GRW | engineering | architecture | geospatial
9710 Bunsen Parkway | Louisville, KY 40299
502.489.8484 | www.grwinc.com

September 27, 2017

Mr. Jory Becker, P.E.
Env. Engineering Branch Manager
Water Infrastructure Branch
Division of Water
300 Sower Boulevard
Frankfort, KY 40601

Re: Brandenburg Wastewater Facilities Plan
Planning Period 2017-2037
City of Brandenburg, Kentucky
GRW Project No. 4556

Dear Mr. Becker:

On behalf of the City of Brandenburg, we have enclosed two (2) hardcopies and one (1) CD of Brandenburg's Regional Wastewater Facilities Plan along with a copy of the Regional Facilities Plan Preparation Checklist located inside each binder.

A public hearing will held at a later date upon KDOW's cursory review of the enclosed plan. Documentation for public hearing will be submitted at a later date.

Please feel free to contact me if you have any questions or comments. I may be reached at 502-489-8484 or at jpavoni@grwinc.com.

Sincerely,

Joseph V. Pavoni

Joe Pavoni, P.E., LEED AP
Project Manager

Enclosures: Two (2) copies of Brandenburg Regional Facilities Plan
One (1) CD of Brandenburg Regional Facilities Plan and shapefile of planning area

cc: Mayor Ronnie Joyner, City of Brandenburg, w/ enclosure
T.J. Hughes, City of Brandenburg, w/ enclosure

Section 12: Regional Facility Plan Completeness Checklist and Forms

Requirements: Two (2) hard copies, one certified by a professional engineer licensed in Kentucky and one (1) non-certified digital copy of the regional facility plan and the planning area shapefile on a Compact Disc (CD) shall be submitted to the Cabinet. This completeness checklist should be completed and submitted with each regional facility plan.

Regional Planning Agency Name: City of Brandenburg

Date: September 2017

		PAGE #
SECTION 1		
REGIONAL FACILITY PLAN SUMMARY- This section shall provide a brief summary of the information provided in the facility plan, including the following:		
1.	Purpose of the plan and major problems evaluated in the plan.	1-1
2.	Recommended alternative chosen to remediate or correct the problems and/or serve the area of need identified in the plan. Also, include any institutional arrangements necessary to implement the recommended alternative(s).	1-5 & 7-1
3.	Estimated cost of implementing the proposed plan (including user fees) and the proposed funding method to be used.	1-6 & 9-5
4.	Planning agency commitments necessary to implement the plan.	8-1
5.	Schedule of implementation for projects.	6-10 & App. B
SECTION 2		
STATEMENT OF PURPOSE AND NEED- This section shall contain a brief description of the purpose and need for a submitting the facility plan.		2-1
SECTION 3		
PHYSICAL CHARACTERISTICS OF THE PLANNING AREA- This section shall delineate the planning area boundaries and describe key topographic, geographic and pertinent natural or man-made features of the area. Digital or electronic submission of the planning area boundary shapefile in a standard GIS format shall also be included. This section shall also include the following maps:		
1.	One (1) up-to-date map, suitable for photocopying, indicate the planning area boundary, service area boundary, watershed boundaries, county lines, populated places, cities and/or towns and project areas or proposed planning period phases.	Exh. 2-2, 2-6, & 2-7
2.	One (1) up-to-date map, suitable for photocopying, include locations of wastewater treatment facilities (including package treatment plants), discharge location(s), collection lines (gravity, force main, interceptors), pump stations, public drinking water intake points and groundwater supply areas [Source Water Area Protection Plans (SWAPP) and/or Wellhead Protection Areas (WHPA)].	Exh. 2-7 & 5-1
3.	One (1) seven and one-half (7 ½) minute USGS topographic map including the location of wetlands, delineation of the 100-year floodplain, surface water(s), and topography.	Exh. 2-8

4.	If available, a local planning and zoning land use map.	Exh. 2-4
	SECTION 4	
SOCIOECONOMIC CHARACTERISTICS OF THE PLANNING AREA- The following characteristics of the planning area shall be discussed:		
1.	Historical, current, and projected population in the planning area including wastewater contributions from industrial and commercial sources.	3-1 & Exh. 3-1
2.	Current and projected population in the existing service area and unsewered parts of the planning area	Exh. 3-1
3.	Economic or social benefit to the affected community	3-3
	SECTION 5	
EXISTING ENVIRONMENT IN THE PLANNING AREA- Describe existing physical, biological, cultural, and other resource features within the planning area with an emphasis on those that may be impacted by the proposed plan or projects, including the following:		
1.	Physical features such as surface and groundwater quality, water sources and supply, wetlands, lakes, streams, air pollution, floodplains, soils, geology, and topography	2-6 - 2-9
2.	Biological: Identify plant and animal communities in the planning area with an emphasis upon endangered and threatened species likely to be impacted	2-8
3.	Cultural: Describe archaeological and historical resources that may be affected by the proposed project	2-10
4.	Other Resource Features such as national and state parks, recreational areas, USDA Designated Important Farmland, and any other applicable environmentally sensitive areas	3-2
	SECTION 6	
EXISTING WASTEWATER SYSTEM- This section shall be prepared by a Professional Engineer licensed in Kentucky. A description of the existing facilities within the planning area shall include the following:		
1.	On-site systems in the planning area	5-1, 5-2, Exh. 5-1 & 5-2
2.	Physical condition of the existing wastewater treatment plant(s) including the type, age, design capacity, process units, peak and average wastewater flows, current discharge permit limits, schematic layout of treatment plant. Include a narrative description of the capacity of the treatment plant to meet reliability and redundancy requirements as outlined in regulation 401 KAR 5:005, Section 13.	5-3 - 5-12, Exh. 4-1, & App. D
3.	Existing collection and conveyance system and its condition	5-1 - 5-3 & Exh. 5-1
4.	Existing biosolids disposal method	5-12
5.	Existing operation, maintenance and compliance issues	5-12 - 5-13
	SECTION 7	
FORECASTS OF FLOWS AND WASTE LOADS IN THE PLANNING AREA- This section shall be prepared by a professional engineer licensed in Kentucky and shall include:		
1.	Current and projected commercial, industrial and residential growth for the proposed planning period	4-1 - 4-2 & Exh. 4-2
2.	A copy of the waste load allocation (WLA) issued by the DOW for new or expanded treatment plant projects	App. E

SECTION 8		
EVALUATION OF ALTERNATIVES- This section shall be prepared by a professional engineer licensed in Kentucky and include an assessment of alternatives to determine the appropriate facilities that will meet the wastewater needs of the planning area and provide benefits that are cost-effective and environmentally sound. The section shall include:		
1.	No-action alternative	6-5
2.	Optimization of existing facilities	6-2 - 6-6
3.	Regionalization	2-3 - 2-4
4.	Other alternatives	6-2 - 6-6
5.	Detailed cost analysis along with 20 year present worth analysis for each alternative	6-6, & Exh. 6-1.2 - 6-6.4
6.	Recommended alternative	6-5, 7-1, & Exh. 7-1 - 7-2
SECTION 9		
CROSS-CUTTER CORRESPONDENCE AND MITIGATION- Each facility plan shall include cross-cutter correspondences to and from each agency related to the following four environmental and cultural concerns:		
1.	Threatened and Endangered Species: The U.S. Fish and Wildlife Service- Kentucky Ecological Services Field Station and the Kentucky Department of Fish and Wildlife Resources	App. H
2.	Historical Resources: The Kentucky Heritage Council State Historic Preservation Office	App. H
3.	Aquatic Resources: The US. Army Corps of Engineers (Louisville, Nashville, or Huntington Districts).	App. H
4.	Agricultural Resources: The local office of the Natural Resources Conservation Service (NRCS) or USDA Service Center	App. H
SECTION 10		
EVAULATION OF RECOMMENDED REGIONAL FACILITY PLAN- This section of the facility plan shall summarize the critical components of the recommended plan.		
1.	Environmental impacts	6-7
2.	Institutional structure	6-8
3.	Funding plan	9-1 - 9-5
4.	Current and projected residential user charge rate based on 4,000 gallon usage per month	9-1 & Exh. 9-1 - 9-3
5.	Implementation schedule	6-10 & App. B
SECTION 11		
DOCUMENTATION OF PUBLIC PARTICIPATION- The section shall include a copy of the newspaper advertisement/proof of publication, attendance sheet, and public comments.		8-1 & App. J

Planning Period 2017 - 2037

Wastewater Facilities Plan

GRW Project No. 4556

City of Brandenburg, KY

September 2017

CITY OF BRANDENBURG

engineering | architecture | geospatial

GRW | 9710 Bunsen Parkway | Louisville, KY 40299 | 502.489.8484

Wastewater Facilities Plan
City of Brandenburg, Kentucky
Planning Period 2017 – 2037

<u>Mayor</u>

The Honorable Ronnie Joyner

<u>Public Works Director</u>

T.J. Hughes

<u>City Council Members</u>

Bruce Fackler	**Chris Hulsey**
Bryan Claycomb	**Patsy Lusk**
Maggie Love	**Scotty Applegate**

STATE OF KENTUCKY
JOSEPH V. PAVONI
23410
LICENSED
PROFESSIONAL ENGINEER

9-27-17

Wastewater Facilities Plan
City of Brandenburg, Kentucky
Planning Period 2017 – 2037

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Chapter 5 – Existing Facilities .... 5-1 – 5-13

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Wastewater Facilities Plan
City of Brandenburg, Kentucky
Planning Period 2017 – 2037

Appendices

Appendix A – Brandenburg Agreed Order

Appendix B – Brandenburg Corrective Action Plan (CAP)

Appendix C – Planning Area Boundaries & Phases

Appendix D – Brandenburg WWTP KPDES Permit

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Appendix G – Existing Rates and Charges

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Appendix J – Public Meeting Minutes, Public Meeting Presentation, Attendance Roster, Public Comments, Affidavit of Publication, and The Meade County Messenger Tear Sheets

Appendix K – Design Calculations

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Appendix M – Lagoon Sludge Survey

Appendix N – Sewer Use Ordinance

Chapter 1
Executive Summary

A. Purpose

The City of Brandenburg, in cooperation with the Kentucky Division of Water (KDOW), determined that their 1990 Wastewater Facilities Plan needed to be updated. Brandenburg's Wastewater Treatment Plant (WWTP) had numerous KPDES permit violations between May 2011 and December 2015, which resulted in the City entering into an Agreed Order on June 14, 2016 with the Kentucky Energy and Environment Cabinet Division of Enforcement. One of the Agreed Order requirements was for the City to complete a Corrective Action Plan (CAP) to bring the WWTP back into compliance. The CAP recommended that the City update their Wastewater Facilities Plan. GRW Engineers, Inc. was selected and contracted by Brandenburg to update that Facilities Plan.

B. Background

The existing Brandenburg WWTP in Brandenburg, Kentucky is located on Buttermilk Falls Road east of downtown Brandenburg. The plant discharges near National Hydrography Dataset (NHD) mile point 643.3 of the Ohio River, segment 08217. It currently has a design treatment capacity of 0.312 million gallons per day (MGD) with a peak hydraulic capacity of 0.932 MGD. The plant was constructed in 1993 to replace the original WWTP built in 1963.

The Brandenburg wastewater collection system is considered "separate" as opposed to "combined", which means that there are separate pipes dedicated to transporting storm and sanitary flows. The collection system was originally constructed in the early 1960's and encompassed downtown Brandenburg, as well as areas south of downtown. Since that time, the sewer system has expanded to accommodate the City's population growth. Due to Brandenburg's topography, the system is primarily gravity flow, but requires numerous lift stations with short force mains.

C. Planning Period

In accordance with the provisions of Section 401 KAR 5:006, the Planning Period for the Brandenburg Facilities Plan Update will be over a 20-year period, and will include the period of time from 2017 to 2037.

D. Planning Area

The existing Brandenburg Planning Area was delineated in the 1990 Wastewater Facilities Plan and included the area within the city limits. The planning area boundary has been modified for the purposes of this study. The rationale behind altering the boundary was based on the city limits growing slightly since 1990, as well as to reflect the geographic areas in which it is feasible for the City of Brandenburg to provide wastewater service over the next 20 years. At the time of this document's submittal to KDOW, the formally approved planning area boundary is the one contained in the 1990 Facilities Plan. The new 2017 Planning Area, however, has been used for the purposes of population, land use, flow projections, and recommended improvements in this update. Exhibit 1-1 shows Brandenburg's 2017 Planning Area Boundary, as well as the 0-2 year, 3-10 year and 11-20 year expansion areas.

E. Planning Methodology

This study will develop a plan for the most environmentally sound, cost-effective and implementable wastewater collection and treatment system improvements. It will investigate the effectiveness of the existing treatment plant, disinfection alternatives, the proposed treatment plant alternatives, as well as the ability of the collection system to meet all applicable Federal, State and local requirements. Specifically, this planning document shall objectively evaluate the combined effect of a two component analysis: 1)

Cost Effective Analysis and 2) Non-monetary Effectiveness Analysis.

Each alternative under consideration was evaluated using a systematic approach to obtain a ranking for each of the two analysis components.

The systematic approach for evaluating alternatives within the framework of each component consisted of:

1. Cost Effective Analysis

The Cost Effective Analysis involved comparing the cost associated with each alternative based on the present-worth cost analysis method.

2. Non-monetary Effectiveness Analysis

The Non-monetary Effectiveness Analysis includes both the Environmental Impact Analysis and the Implementation Analysis.

F. ***Population Projections***

The most recent census data, as well as population projections for Brandenburg and Meade County, are as follows:

Table 1-1
Brandenburg and Meade County
Population Projections

Year	Meade County	Brandenburg
2010	28,602	2,643
2015	27,924	2,852
2020	27,395	2,798
2025	26,780	2,735
2030	26,025	2,657
2035	25,127	2,565
2037	24,703	2,521

The justification for the Table 1-1 figures can be found in Chapter 3. The Brandenburg population projections were used in conjunction with proposed land use for preparing wastewater flow and pollutant load projections.

G. ***Wastewater Flow Projections***

Wastewater flow projections for the Brandenburg Planning Area for the year 2037 (end of 20 year planning period) are as follows:

Table 1-2
Planning Area Wastewater Flow Projections
Year 2037

Service Area	Average Flow (MGD)	Peak Flow (MGD)
Existing Service Area	0.206	0.337
Expansion Area No. 1	-	-
Expansion Area No. 2	0.017	0.029
Expansion Area No. 3	0.045	0.074
Total	**0.268**	**0.439**

The projected 2037 flows are 0.268 MGD average daily flow and 0.439 MGD peak hydraulic flow. The projected flows do not exceed the WWTP's current design average or peak hydraulic flows. Since 20-year projections indicate that only 86% of the plant's hydraulic capacity will be utilized in 2037, it is not required that the plant capacity be expanded. The requirement in the regulation pertaining to plants expansion indicates that when 90% or greater of a WWTP's hydraulic capacity is reached an expansion must take place. This threshold was not met. As a result, current WWTP design flows were used instead of the projected 2037 flows. The justification for the Table 1-2 figures can be found in Chapter 4.

H. ***Existing and Proposed Treatment Plant Capacity***

The following table summarizes the current and proposed (2037) Brandenburg WWTP capacity:

Table 1-3 Current and Proposed Brandenburg WWTP Capacity		
Influent Parameter	**Current Design Capacity**	**Proposed Design Capacity**
Avg Daily Flow (MGD)	0.312	0.312
Peak Hourly Flow (MGD)	0.932	0.932
BOD_5 (lbs/day)	870	1052
BOD_5 (mg/l)	334	404
TSS (lbs/day)	840	100
TSS (mg/l)	323	384
Ammonia-Nitrogen (mg/l)	27	27
Phosphorus (mg/l)	-	-
Total Nitrogen (mg/l)	-	-

The justification for these figures can be found in Chapter 4. As previously mentioned, the projected 2037 flows do not exceed the current WWTP's design flows. Therefore, the WWTP will not be expanded. All upgrades will be implemented in an effort improve the treatment process and meet the KPDES permit limits.

I. ***Existing Effluent Limits***

The existing KPDES permit effluent limits are presented in Appendix D. A summary of the existing KPDES permit effluent limits are presented in Table 1-4.

Table 1-4 Existing Monthly Average KPDES Permit Limits	
Effluent Parameter	**Value**
BOD_5	30 mg/l
TSS	30 mg/l
Ammonia-Nitrogen	20 mg/l
Total Phosphorus	Monitor
Dissolved Oxygen (min.)	2 mg/l
Total Residual Chlorine	0.019 mg/l
Total Nitrogen	Monitor
pH (min./max.)	6.0/9.0 SU
E. Coli	130 #/100ml

J. ***Treatment Plant Alternatives***

Various treatment plant alternatives were evaluated for the WWTP with the objective of eliminating KDPES permit violations and providing sufficient treatment capacity for current and future flows and waste loads. The following treatment alternatives were evaluated:

Table 1-5 Treatment Alternatives	
Alternative 1	Addition of Polishing Reactor
Alternative 2	Waving Biomedia
Alternative 3	Diffusers & Polishing Reactor
Alternative 4	"Greenfield" Lagoon
Alternative 5	Oxidation Ditch
Alternative 6	No Action

Disinfection was evaluated for each of above treatment alternatives. The disinfection alternatives were evaluated on the present worth analysis and selected based on the City's preferred alternative, and included in the cost of the alternatives listed above. Disinfection alternatives are listed in Table 1-6. The selected alternative is indicated in bold.

Table 1-6 Disinfection Alternatives	
Alternative 1	Ultraviolet (UV) Light
Alternative 2	**Peracetic Acid (PAA)**
Alternative 3	Chlorination/Dechlorination

A discussion and analysis of each of the treatment and disinfection alternatives can be found in Chapter 6.

K. ***Present Worth Analysis***

The present worth analysis values for each of the treatment alternatives are summarized in Table 1-7.

Table 1-7 Present Worth Values for Treatment Alternatives	
Alternative 1 – Addition of Polishing Reactor	$10,911,000
Alternative 2 – Waving Biomedia	$9,771,000
Alternative 3 – Diffusers & Polishing Reactor	**$9,550,000**
Alternative 4 – “Greenfield” Lagoon	N/A
Alternative 5 – Oxidation Ditch	N/A
Alternative 6 – No Action	N/A

Present worth values for Alternatives 4 and 5 were not determined after preliminary construction costs were evaluated and discussions with the City of Brandenburg deemed that further analysis was not warranted.

Based on present worth analysis the diffusers and polishing reactor is the preferred treatment alternative. A more detailed summary of the present worth analysis is provided in Exhibit 1-2. A discussion of the present worth analysis for the treatment alternatives can be found in Chapter 6

L. ***Non-monetary Effectiveness Analysis***

The Non-monetary Effectiveness Unit (NEU) analysis of each treatment alternative is summarized in Table 1-8 (the alternative with the lowest NEU score is the preferred alternative from a Non-monetary Effectiveness perspective).

Table 1-8 Non-monetary Effectiveness Unit (NEU) Ratings	
Alternative 1 – Addition of Polishing Reactor	158,360
Alternative 2 – Waving Biomedia	143,903
Alternative 3 – Diffusers & Polishing Reactor	**132,271**
Alternative 4 – “Greenfield” Lagoon	N/A
Alternative 5 – Oxidation Ditch	N/A
Alternative 6 – No Action	N/A

Non-monetary effectiveness analysis for Alternatives 4 and 5 were not determined after preliminary construction costs were evaluated and discussions with the City of Brandenburg deemed that further analysis was not warranted.

Based on Non-monetary Effectiveness analysis the diffusers and polishing reactor is the preferred treatment alternative. The detailed Non-monetary Effectiveness analysis rating table is presented in Exhibit 1-3 and a further discussion of the Non-monetary Effectiveness analysis is contained in Chapter 6.

M. ***Collection System Alternatives***

The collection system alternatives that were evaluated for the Brandenburg sewer system expansion are identified in Table 1-9.

Table 1-9 Collection System Alternatives	
Alternative 1	**Gravity Collection System**
Alternative 2	Vacuum Collection System
Alternative 3	Low Pressure Collection System

The expansion of the existing gravity collection system is the selected alternative. The estimated cost of each of the recommended gravity collection system expansion phases are summarized in Table 1-10.

Table 1-10 Gravity Collection System Expansion Phases Cost Estimate	
3-10 Years	$3,023,000
11-20 Years	$3,762,000

The 3-10 and 11-20 year phases are designed to expand the existing collection system. Both phases propose adding neighborhoods currently on Brandenburg's water system to the collection system. The City may or may not choose to serve these potential customers. Exhibit 1-4 shows the proposed collection system expansion for each phase, and Exhibits 1-5 and 1-6 provides a preliminary total project cost estimate for the recommended 3-10 and 11-20 year phase expansions. A discussion and analysis of the collection system alternatives and planning phases can be found in Chapter 6.

N. *Selected Plan*

Treatment Plant: The selected treatment alternative is Alternative 3 – Diffusers and Polishing Reactor. The diffusers and polishing reactor alternative meets all project goals and objectives and has the lowest present worth cost and the best Non-monetary Effectiveness rating. The plant will maintain its current rated 0.312 MGD average daily flow and 0.932 MGD peak hydraulic flow. Elements of the recommended plant upgrades are described below. A further discussion of the recommended plant upgrades are contained in Chapter 6.

The existing screening channel will have concrete repairs, installation of grating over the channels, electrical modifications, raise overflow weir height, removal of existing manual bypass screen, moving existing mechanical inline grinder/screen/compactor to bypass channel, and addition of new mechanical inline grinder/screen/compactor in main channel.

The existing screen effluent – Box No. 1 will have repairs made to the concrete in an effort to reduce future corrosion from hydrogen sulfide gas.

The existing facultative lagoons will have all sludge and liners removed. Lagoon No.1 will be have earth under liner repaired, relined, and installation of baffle and diffusers. DO probes will be added to Lagoon No. 1. Lagoon No. 2 will be abandoned.

A new polishing reactor will be constructed after Lagoon No.1 to provide ammonia-nitrogen removal.

The existing chlorine storage facility, chlorinators, and induction pump will be removed. The chlorination induction station will be abandoned.

The existing clarifiers will be abandoned.

The existing decant manhole will be abandoned.

The existing scum/sludge/dewater pump station will be abandoned.

The sulfur dioxide storage facility, sulfonators, and induction pump will be removed. The dechlorination induction station will be abandoned.

The new PAA disinfection system will require the installation of peristaltic pumps, piping, and chemical totes. Spill containment will be constructed for the pumps, piping, and chemical storage.

A new contact tank will be constructed to provide the necessary contact time for the new PAA disinfection system.

The existing plant effluent will have grating added over the channel.

The existing outfall will have the flow dispersal pier from the original design added. The rip rap channel will have debris removed and new rip rap added.

The existing control building will have new lighting added and missing or deteriorating ceiling tiles replaced.

The existing site lighting will be replaced, access drive repaved, and supervisory control and data acquisition (SCADA) and a generator will be added.

Exhibit 1-7 presents the flow diagram for the selected treatment alternative and Exhibit 1-8 presents the site layout for the selected treatment alternative.

Collection System: The collection system projects identified in the 3-10 and 11-20 year planning phase to expand the existing collection system are in Table 1-11 and 1-12.

O. *Project Cost Estimate*

The total project cost for the recommended plant improvements and disinfection alternative (Alternative 3 – Diffusers and Polishing Reactor) is estimated at $3,312,382 and the total project cost estimate for the potential collection system expansion in the 3-10 and 11-20 year timeframe are $3,023,000 and $3,762,000, respectively. The total 20 year cost estimate for both treatment plant improvements and collection system expansion is $10,097,382. The City of Brandenburg intends on funding the improvements using a combination of loans and grants backed by a series of sewer user rate increases.

Table 1-11
3-10 Year Planning Phase
Proposed Collection System Expansion

Four Oaks Road Neighborhood		
Gravity Sewer	8”	2,440’
Force Main	2”	910’
	4”	1,640’
Duplex Lift Stations	2	
Quail Run and Knollwood Neighborhood		
Gravity Sewer	8”	11,770’
Force Main	4”	2,810’
Duplex Lift Stations	7	

Table 1-12
11-20 Year Planning Phase
Proposed Collection System Expansion

River Edge Road Neighborhood		
Gravity Sewer	8”	5,320’
Windsor Place and Sun Valley Road Neighborhood		
Gravity Sewer	8”	7,820’
Force Main	4”	2,000’
Duplex Lift Stations	1	
Christian Church and Bud Wilson Road Neighborhood		
Gravity Sewer	8”	8,780’
Force Main	2”	1,700’
	4”	4,150’
Duplex Lift Stations	7	

The 3-10 and 11-20 year planning phases will each require numerous duplex lift stations to provide sanitary sewers to each neighborhood. A separate preliminary engineering study would be recommended prior to the design of sanitary sewers to each neighborhood. The preliminary engineering study would investigate the alternative collection systems (i.e. grinders or low pressure force mains) for each neighborhood and recommend the best alternative for providing sanitary sewers to each neighborhood. **The City may or may not choose to serve the potential customers within the 3-10 and 11-20 year phases.**

P. *Sewer User Rates*

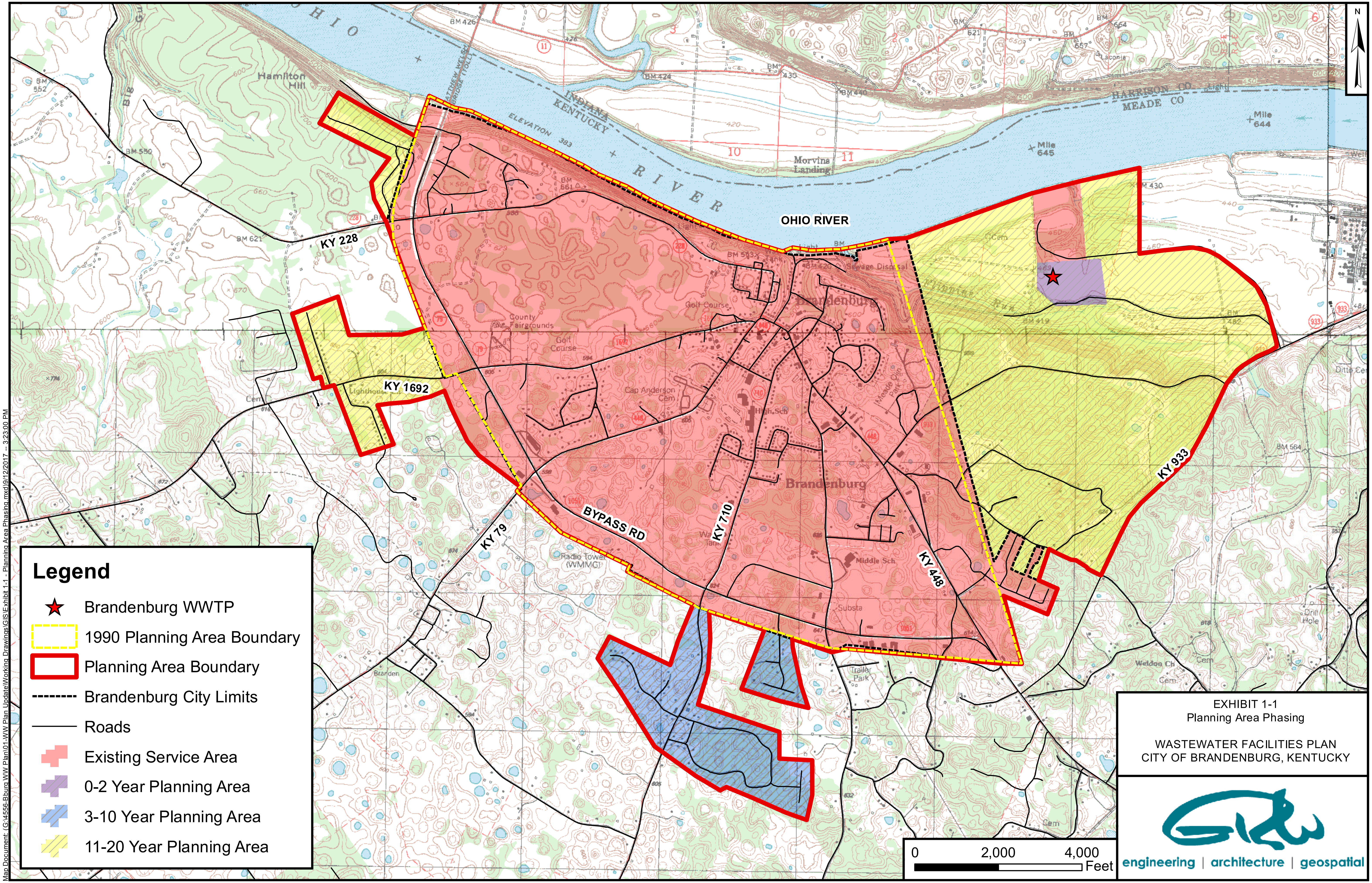
A preliminary sewer use rate analysis has been completed using a combination of loan and grant funds. No impact fees (i.e. new user tap fees) or recapture agreement fees were considered in the rate analysis. The analysis results are included as Exhibits 9-1 through 9-3. Three funding scenarios were evaluated: two using a loan at the current standard SRF interest rate of 1.75% over 20 years, along with a 0.2% administrative fee to fund the non-grant portion of the improvements and one using a loan at the current standard RD interest rate of 2.625% over 40 years.

For funding Scenario 1, with no grant money and a 20 year loan interest rate of 1.75% (plus 0.2% administrative fee), sewer use rates are projected to increase from $26.19 per 4,000 gallons to $39.59 per 4,000 gallons for residents inside the city, and from $27.73 per 4,000 gallons to $41.92 per 4,000 gallons for residents outside the city.

For funding Scenario 2, with a 30% loan forgiveness and a 20 year loan interest rate of 1.75% (plus 0.2% administrative fee), sewer use rates are projected to increase from $26.19 per 4,000 gallons to $35.96 per 4,000 gallons for residents inside the city, and from $27.73 per 4,000 gallons to $38.07 per 4,000 gallons for residents outside the city.

For funding Scenario 3, with a 30% grant and a 40 year loan interest rate of 2.625%, sewer use rates are projected to increase from $26.19 per 4,000 gallons to $33.15 per 4,000 gallons for residents inside the city, and from $27.73 per 4,000 gallons to $35.10 per 4,000 gallons for residents outside the city.

It should be noted that these are preliminary rate calculations and a more detailed rate study must be completed in order to verify the actual rate increase required. The analysis provided here did not factor in other revenue sources such as new user tap fees or recapture agreement fees. In addition, this projected rate increase assumes that the existing finances are neutral and does not include any rate increase which may be necessary to bring current finances to a neutral position.



OHIO RIVER
INDIANA
KENTUCKY
HARRISON CO.
MEADE CO.
KY 228
KY 1692
KY 79
BYPASS RD
KY 710
KY 448
KY 933
Brandenburg
Legend
Brandenburg WWTP
1990 Planning Area Boundary
Planning Area Boundary
Brandenburg City Limits
Roads
Existing Service Area
0-2 Year Planning Area
3-10 Year Planning Area
11-20 Year Planning Area
0
2,000
4,000
Feet
N
EXHIBIT 1-1
Planning Area Phasing
WASTEWATER FACILITIES PLAN
CITY OF BRANDENBURG, KENTUCKY
engineering | architecture | geospatial

Exhibit 1-2
Brandenburg Wastewater Treatment Plant
Present Worth Analysis Summary

Biological Treatment Alternatives*

Alternative	Description	Project Cost	Annual O&M	Salvage Value	Total Present Worth
1	Addition of Polishing Reactor	$4,674,462	$420,374	$161,040	$10,911,000
2	Waving Biomedia	$3,324,690	$431,810	$93,640	$9,771,000
3	Diffusers and Polishing Reactor	$3,312,382	$419,374	$131,920	$9,550,000

Disinfection Alternatives

Alternative	Description	Construction Cost	Annual O&M	Salvage Value	Total Present Worth
1	Ultraviolet Light	$84,765	$9,212	$11,280	$218,000
2	Peracetic Acid	$268,720	$13,797	$85,888	$428,000
3	Chlorination/Dechlorination	$250,220	$9,342	$83,888	$344,000

*The biological treatment alternatives include total project cost for upgrading the City of Brandenburg's WWTP which includes the selected disinfection alternative.

Exhibit 1-3
Brandenburg Wastewater Treatment Plant
Non-monetary Effectiveness Analysis

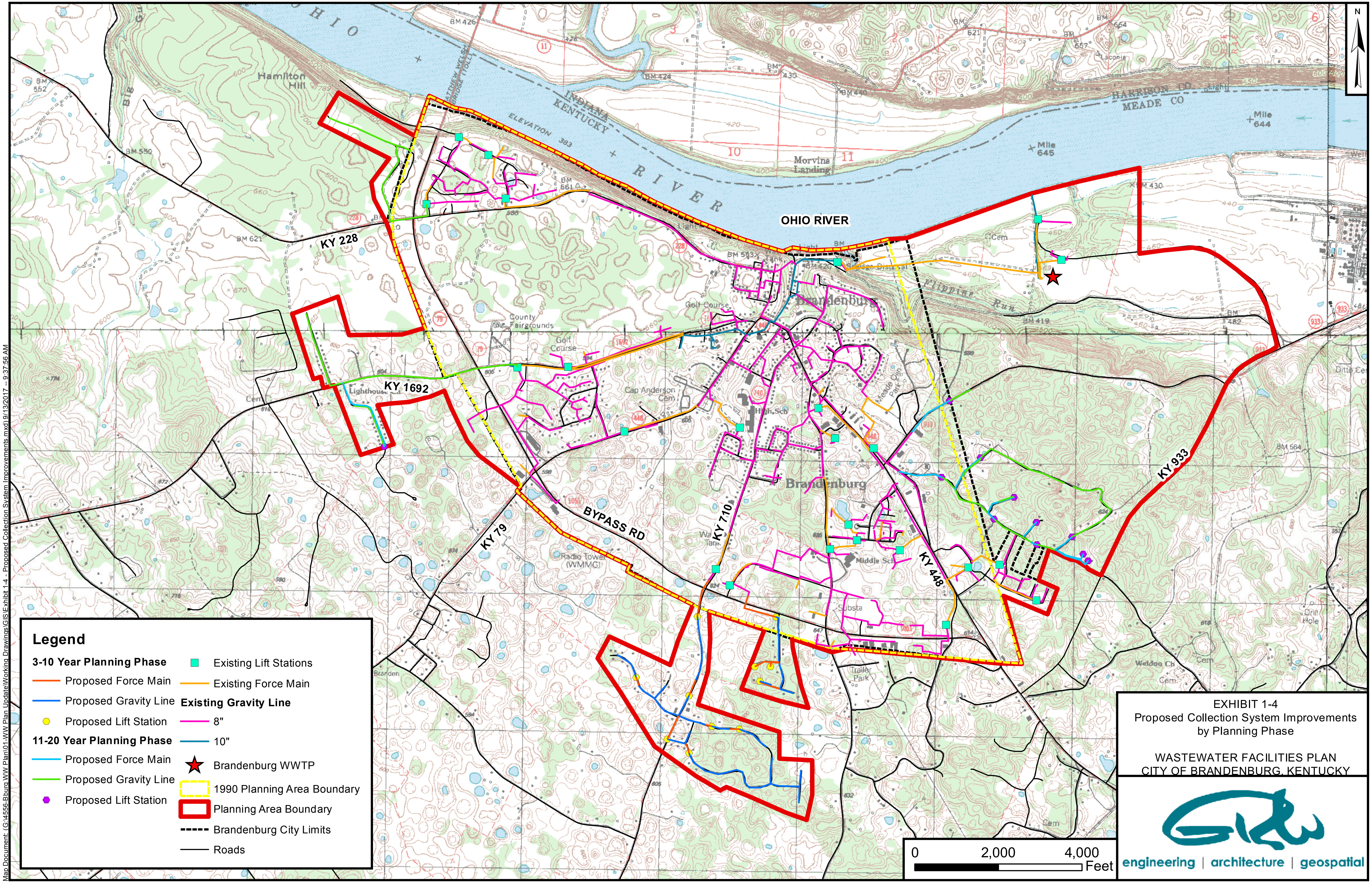
		Alternative 1 Addition of Polishing Reactor		Alternative 2 Waving Biomedia		Alternative 3 Diffusers and Polishing Reactor	
Parameter	**Weight**	**Rating**	**Score**	**Rating**	**Score**	**Rating**	**Score**
Environmental Impact	1.00	9	9.00	9	9.00	9	9.00
Engineering Evaluation	1.00	8	8.00	8	8.00	10	10.00
Implementability	0.90	10	9.00	9	8.10	9	8.10
Energy Consumption	0.80	8	6.40	7	5.60	9	7.20
Expandability	0.70	8	5.60	9	6.30	9	6.30
Chemical Use	0.70	8	5.60	8	5.60	9	6.30
Public Support	0.80	8	6.40	8	6.40	8	6.40
Institutional & Legal Capability	0.90	10	9.00	10	9.00	10	9.00
Regionalization	0.70	7	4.90	7	4.90	7	4.90
Land Purchase & Easements	0.50	10	5.00	10	5.00	10	5.00
Total Score			**68.90**		**67.90**		**72.20**
Total Present Worth			**$10,911,000**		**$9,771,000**		**$9,550,000**
Non-Monetary Effectiveness Units (NEU)			**158,360**		**143,903**		**132,271**

Note: 1. The **Weight** of each parameter is a measure of the relative concerns of that parameter compared to other parameters, on a scale of 0.0 to 1.0, with the highest weighted parameters being those which are considered the most critical.

2. The **Rating** for each alternative is a measure of the relative implementation concern of that alternative on the parameter compared to other alternatives, on a scale of 0.0 to 10.0, with the highest ratings given to the alternative that best satisfies the parameter.

3. The Non-monetary Effectiveness Unit (NEU) is a measure of the relative implementation concern due to construction and operation of each alternative. The alternative with the **lowest NEU is the most capable of implementation**.

4. Non-monetary Effectiveness Units (NEU) = Total Present Worth/Total Score



Map Document: (G:\4556-Bburg WW Plan\01-WW Plan Update\Working Drawings\GIS\Exhibit 1-4 - Proposed Collection System Improvements.mxd) 9/13/2017 -- 9:37:56 AM

Exhibit 1-5
Proposed Wastewater Collection System Improvements
Preliminary Total Project Cost Estimate
3-10 Year Planning Phase

Item	Estimated Cost*
Construction	$2,228,000
Engineering Design	$133,000
Site Surveys	$40,000
Geotechnical Engineering	$60,000
Bidding	$19,000
Construction Administration	$38,000
Resident Inspection	$110,000
Land and Right-of-Way	$20,000
Legal	$10,000
Start Up Services	$30,000
Contingency (15%)	$335,000
Preliminary Total Project Cost Estimate	$3,023,000

* Estimated costs based on 2017 pricing

Exhibit 1-6
Proposed Wastewater Collection System Improvements
Preliminary Total Project Cost Estimate
11-20 Year Planning Phase

Item	Estimated Cost*
Construction	$2,791,000
Engineering Design	$161,000
Site Surveys	$60,000
Geotechnical Engineering	$60,000
Bidding	$23,000
Construction Administration	$46,000
Resident Inspection	$127,000
Land and Right-of-Way	$30,000
Legal	$15,000
Start Up Services	$30,000
Contingency (15%)	$419,000
Preliminary Total Project Cost Estimate	$3,762,000

* Estimated costs based on 2017 pricing

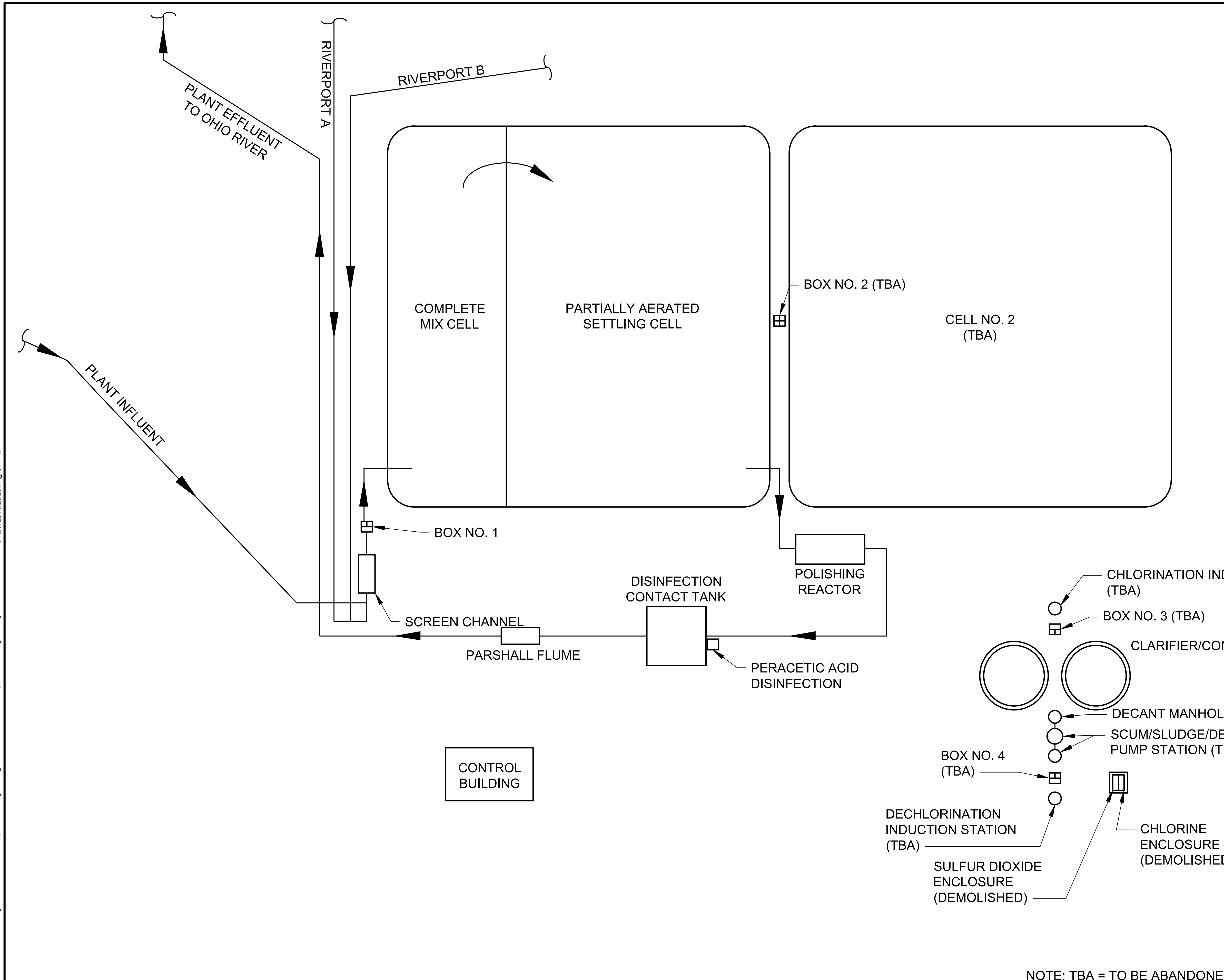
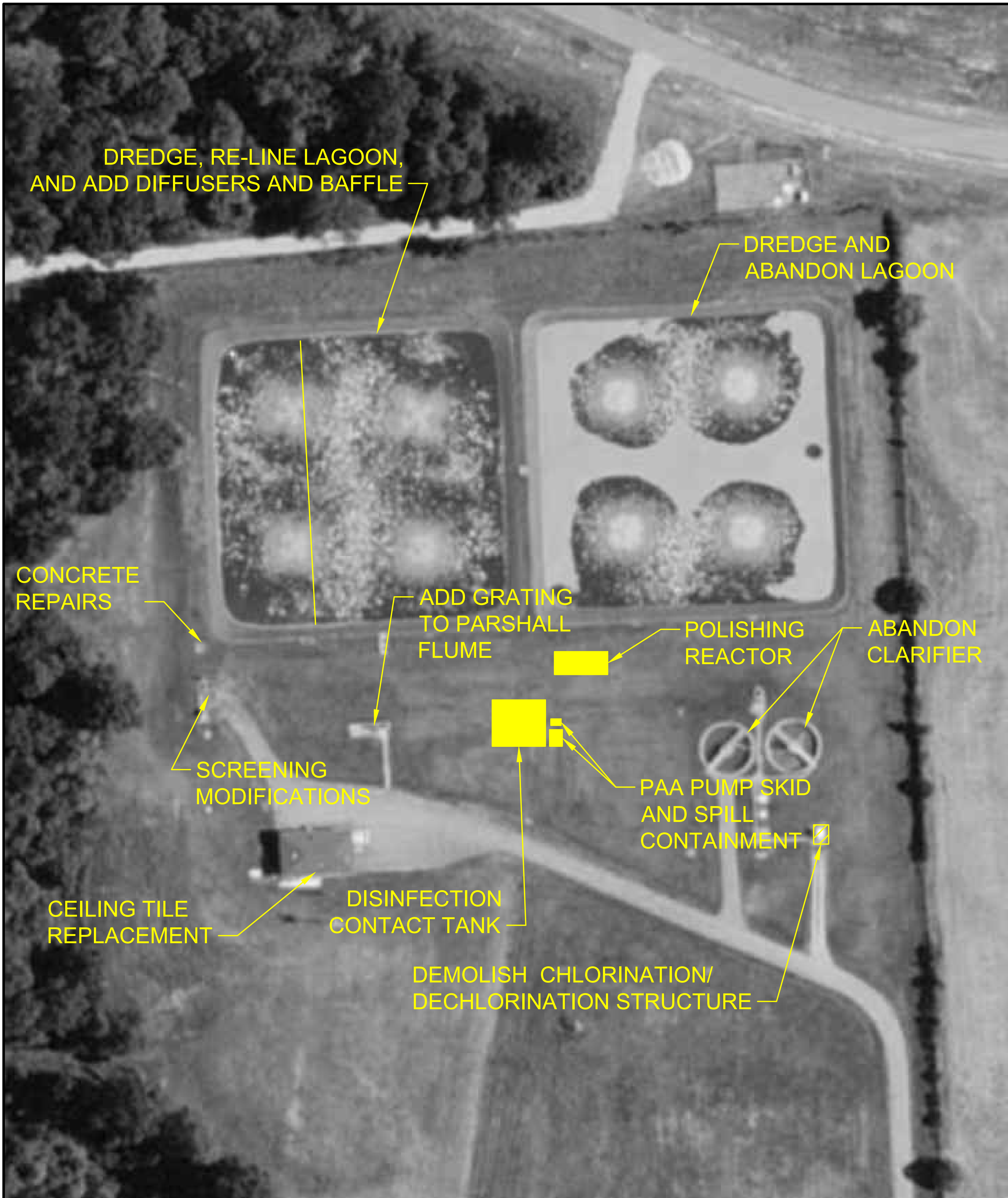


EXHIBIT 1-7
Selected Alternative
(Diffusers & Polishing Reactor)
Flow Diagram
WASTEWATER FACILITIES PLAN
CITY OF BRANDENBURG, KENTUCKY

engineering | architecture | geospatial



GRW PROJECT NO. 4556-01

DIFFUSERS & POLISHING REACTOR
SELECTED ALTERNATIVE

WASTEWATER FACILITIES PLAN
CITY OF BRANDENBURG, KENTUCKY

engineering | architecture | geospatial
www.grwinc.com

DATE: SEPT., 2017
SCALE: 1" = 100'
SHEET NO. EXHIBIT 1-8

Chapter 2
Project Background

A. *Owner and Purpose*

In June of 2016, the City of Brandenburg entered into an Agreed Order (AO Case No. DOW 150453) with the Commonwealth of Kentucky Energy and Environment Cabinet Division of Enforcement. The purpose of the Agreed Order was to resolve compliance issues with the Brandenburg Wastewater Treatment Plant (i.e. KDPES permit effluent limit violations at the outfall of the treatment plant).

One of the requirements of the Agreed Order was for the City submit to Division of Enforcement (DENF) for review and acceptance, a Corrective Action Plan (CAP) to bring the facility into compliance with its KPDES permit. The City of Brandenburg submitted the CAP to DENF on August 15, 2016. The CAP recommended that the City update their Wastewater Facilities Plan (last updated in 1990), and that the WWTP would be upgraded according to the Facilities Plan recommendations. A copy of the CAP, approved on February 1, 2017 via email, can be found in Appendix B.

For the previously stated reasons, the City of Brandenburg, in cooperation with the Kentucky Division of Water (KDOW), requested that the Wastewater Facilities Plan be updated at this time. GRW Engineers, Inc. was selected and contracted by the City to develop this study.

The purpose of this report is to evaluate the current and future wastewater collection and treatment needs for the Brandenburg Planning Area in accordance with Section 401 of the Kentucky Administrative Regulation (KAR) 5:006. The proposed plan for the wastewater collection and treatment system improvements will be the most environmentally sound, cost effective, and implementable alternative while also meeting Federal, State, and Local requirements.

B. *Planning Methodology*

This facilities plan will be used as a planning tool for future improvements to the Brandenburg wastewater collection and treatment system. The report will project the growth expected for the 20-year planning period from 2017 to 2037, and investigate the effectiveness of the current collection and treatment system to accommodate that future growth.

This study uses information from discussions and meetings with representatives from: City of Brandenburg staff; Brandenburg City Council; Brandenburg Mayor; and Kentucky Division of Water. The study also uses information from a review of: existing sewer system plans, specifications, and O&M manuals; historical data; the 1990 Brandenburg Facilities Plan; Kentucky Geological Survey; and various KDOW documents.

The study will develop a plan for the most environmentally sound, cost-effective, and implementable wastewater collection and treatment system improvements. This planning document will investigate the effectiveness of the existing treatment plant, treatment alternatives, disinfection alternatives, and the ability of the collection system to meet applicable Federal, State, and local requirements.

Specifically, this planning document shall objectively evaluate the combined effect of a two-component analysis: 1) cost effectiveness, and 2) non-monetary effectiveness. The non-monetary effectiveness portion will include analyses for the environmental impact and implementability.

Each alternative under consideration was evaluated using a systematic approach to obtain a ranking for each of the two analysis components. The systematic approach for evaluating alternatives within the framework of each component consisted of:

1. Cost Effective Analysis

The Cost Effective Analysis involved comparing the costs associated with each alternative based on the present-worth cost analysis method.

2. Non-Monetary Effective Analysis

The Non-Monetary Effective Analysis included both the environmental impact analysis and the implementation analysis. The environmental impact analysis involved evaluating the system's compatibility with the surrounding environment. Alternative wastewater collection and treatment systems were assessed to determine their environmental impacts and effectiveness. The implementation analysis involved evaluating the practicality of implementing alternatives based on the existing facility, technical issues, and federal, state, and local requirements.

Chapter 6 contains more information regarding the cost effectiveness and non-monetary effectiveness analyses.

C. Compliance Background

1. Agreed Order

As previously mentioned, the City of Brandenburg entered into an Agreed Order with the Commonwealth of Kentucky Energy and Environment Cabinet Division of Enforcement in June 2016 (See Appendix A) due to permit limit violations for BOD_5, TSS, SS% removal, NH_3N, E. Coli. and pH from May 2011 to December 2015. Remedial measures listed in the Agreed Order included: immediate reporting of spills, bypass discharges, upset condition discharges, and releases of substances which would result in the pollution of the waters of the Commonwealth; proper and regular operation and maintenance of the sewage collection system and WWTP; submittal to DENF for review and acceptance, a written CAP to bring the facility into compliance with its KPDES permit; and ceasing of all discharges that degrade the waters of the Commonwealth.

A CAP for the City was prepared and submitted to DENF in August 2016. The CAP recommended updating the City's Wastewater Facilities Plan and upgrading the WWTP according with the Facilities Plan recommendations. These recommendations will be completed upon the approval of this Facilities Plan by KDOW. Additionally, the CAP highlighted work completed at the WWTP between June 2014 and June 2016 in response to the violations. The modifications included: replacement of all 8 aerators, replacement of chlorine and sulfur dioxide pumps, installation of a new clarifier drive and torque control on east clarifier, and various electrical work.

D. Planning Period

In accordance with the provisions of Section 401 KAR 5:006, the Planning Period for the Brandenburg Facilities Plan Update will be over a 20-year period, and will include the period of time from 2017 to 2037.

E. Regional Location

The City of Brandenburg is the county seat of Meade County in North Central Kentucky. The county, is located in the Pennyroyal Region of the state, and is bounded on the north by the Ohio River, the south and east by Hardin County, and the west by Breckinridge County. Meade County has an area of 325 square miles (208,000 acres). The City of Brandenburg is centrally located in the county, and has an incorporated area of approximately 4.24 square miles (2,713 acres).

Brandenburg is geographically located approximately 46 miles southwest of Louisville, Kentucky, approximately 17 miles south of Corydon, Indiana, approximately 26 miles northwest of Radcliff, Kentucky, and approximately 87 miles northeast of Owensboro, Kentucky. Meade County lies in the Ohio River drainage basin.

A map of the region is shown in Exhibit 2-1, a map of Meade County is shown in Exhibit 2-2, and a map of the City of Brandenburg is shown in Exhibit 2-3.

F. *Planning Area*

The Brandenburg Planning Area was originally delineated in the 1990 Wastewater Facilities Plan (Howard K. Bell). The 1990 Planning Area included the area within the City's 1990 city limits. The Planning Area has been modified for the purpose of this study to reflect wastewater service to geographic areas which are realistically feasible to be served over the next 20 year period by the City of Brandenburg.

The new Planning Area has been delineated based on:

- Brandenburg's revised city limits (October 2012),
- Providing service to existing water customers that were outside the 1990 Planning Area,
- Potential industrial and agricultural growth coming to the area. The geographic area encompassed in the Planning Area is sufficient in size to permit an unrestricted analysis of alternative waste treatment methods, as well as to clearly identify and evaluate the cumulative environmental impact of the proposed alternatives.

The existing Planning Area was produced for the 1990 Wastewater Facilities Plan and encompassed the city limits at that time, which included 4.13 square miles. Since the 1990 Wastewater Facilities Plan the city limits have expanded slightly to the east to encompass residential growth. See Exhibit 2-4 for 1990 Planning Area Boundary and existing land use map.

The boundary of the 2017 Planning Area for wastewater service was determined through meetings with the Brandenburg Mayor and City Staff in January of 2017. GRW and the City then met with KDOW staff in March of 2017 to review the new planning area boundary. KDOW staff did not indicate any objections to the new planning area boundary at that time. A great deal of thought was given on how to expand the 1990 Planning Area, which was initially modified to encompass the revised city limits. Next, the City wanted to potentially provide sanitary sewers to all of their existing water customers. As a result, the Planning Area was increased to include five separate neighborhoods currently on city water. Lastly, areas of potential development were included in the Planning Area. Industrial and agricultural development were added on the east side of Brandenburg along the Ohio River, as well as the existing WWTP site.

The 2017 Planning Area boundaries consist of roughly: the Ohio River to the north, KY 933 to the east, and KY 1051 to the south and west. The south and west boundary extends past KY 1051 in areas to encompass select neighborhoods currently served by the City's water system. In general, it is within the Ohio River watershed. See Exhibit 2-5 for the 2017 Planning Area Boundary and future land use map. See Exhibit 2-6 for Planning Area Phasing. Larger version of Exhibit 2-6 showing the 1990 and 2017 planning areas, respectively, can be found in Appendix C.

Currently, the formally recognized Planning Area is still the same as it was in the 1990 Facilities Plan. Through discussions with City Staff and KDOW, however, it was determined that the City was best suited and most likely to serve the proposed area area, hence the creation of the 2017 Planning Area Boundary. As a result, all population, land use, flow projections, and recommended improvements in this Plan are based on the 2017 Planning Area Boundary. City and County resolutions accepting the new Planning Area Boundary can be found in Appendix I.

G. *Regionalization*

As mentioned previously, Brandenburg is geographically located approximately 26 miles northwest of Radcliff, Kentucky, which has a population of approximately 22,000 people. Although the size of Radcliff makes it one of the larger cities in the state of Kentucky – which could provide a good base for a regional wastewater district – it is a considerable distance from Brandenburg in terms of wastewater conveyance. The economy of scales, even considering the combined populations of the two communities, would not be adequate to justify the cost of conveyance to Radcliff for the relatively small amount of flow from the City of Brandenburg.

Approximately five miles to the southeast lies Doe Valley, a private lakeside community with a population of approximately 1,931 that currently owns and operates a wastewater collection and treatment system. Though close in proximity to Brandenburg and having a relatively large customer base, Doe Valley has recently built a new 200,000 GPD extended aeration package treatment plant. As a result, expanding the planning area to include Doe Valley was not considered.

H. Planning Scope

The tasks undertaken as part of this Planning Study are restricted to the 2017 Planning Area previously described and shown in Exhibit 2-6. The plan will include information and evaluations to assure that the most cost-effective and environmentally sound means of achieving the established water quality goals can be implemented.

The planning process involved investigating the environmental conditions of the 2017 Planning Area; evaluating treatment alternatives; evaluating the cost-effectiveness, environmental, engineering, public support, regionalization, and implementation impacts of each alternative; and selecting a recommended plan.

The Facilities Plan Update includes the following elements:

1. A description of population trends expected inside the 2017 Planning Area along with a description of the projected wastewater flows associated with the projected trends.

2. Descriptions of the existing wastewater collection and treatment system components. These descriptions include all elements of the system from the collection sewers through treatment to the ultimate discharge of treated wastewater to the Ohio River.

3. An assessment of inflow and infiltration in the existing sewage collection system.

4. A cost-effective analysis of alternatives for both the treatment plant and wastewater collection system.

5. An identification of effluent discharge limitations.

6. A non-monetary effectiveness analysis which assesses the expected environmental, engineering, public support, regionalization, and implementation impacts of the disinfection alternatives.

7. A description of the Agreed Order (AO) and Corrective Action Plan (CAP). A copy of the AO can be found in Appendix A, while the CAP can be found in Appendix B.

8. A description of the selected alternative for the treatment plant and collection system improvements.

9. Required comments or approvals from relevant federal, state, and local agencies.

10. A summary of public meetings and hearings held during the planning process, including a summary of the views expressed.

11. A statement demonstrating that the authorities implementing the plan have the legal, financial, institutional, and managerial resources available to ensure the construction, operation, and maintenance of the proposed treatment plant and collection system improvements.

I. Physical and Environmental Setting

1. Land Use

The City of Brandenburg has an existing zoning map (October 2012) including residential, commercial, industrial, and agricultural zones. Additionally, there are a few locations not included within this zoning map that currently contain sanitary sewer customers. These zoning locations were used to designate the existing land uses are shown in Exhibit 2-4. From this land use map, the following table was developed which gives the land use acreages and percentage of total area.

Table 2-1 Existing Brandenburg Land Use		
Land Use Designation	**2017 Acreage**	**% of Total Area**
Single Family Residential	584	21.0%
Two Family Residential	274	9.9%
Multi-Family Residential	185	6.6%
Commercial	765	27.5%
Industrial	339	12.2%
Utilities	37	1.3%
Agriculture	594	21.4%
Total Area	**2,778**	**100.0%**

As is evident from the above table, the most common uses of land in the City are single-family residential, commercial, and agriculture.

The heaviest concentration of residential land use is around the downtown area of the city. As the City has grown in size, the residential development has occurred east, west, and south of downtown along the major roads in and out of city center: Broadway, High Street, Hillcrest Drive, and Lawrence Street.

Commercial land use within the City of Brandenburg is predominately located along the By Pass Road corridor from Broadway west to Hillcrest Street, along the Broadway corridor from Meade-Olin Road south to By Pass Road, and along the Old Ekron Road corridor from Happy Ridge Road south to By Pass Road. Additional pockets of commercial land are located around downtown and in the northwestern part of the City along By Pass Road. The By Pass Road corridor is expected to continue to attract commercial development since it is the main thoroughfare to access the bridge crossing the Ohio River from Kentucky to Indiana.

Industrial use is generally concentrated in the southeast and west sections of the City. Currently, there is the 58-acre Bill Corum Industrial Park located on Armory Road. Additionally, there are individual industrial land use sites located along the By Pass Road and Broadway corridor. The Meade County-Brandenburg Industrial Development Authority is continually trying to bring additional industrial development to the park, as well as other parts of the City and County. Monument Chemical, approximately one and a half miles northeast of the Brandenburg WWTP, is the largest industry in the area, but currently treats their wastewater with a 9.34 MGD on-site package treatment plant. Monument Chemical's plant is almost 30 times larger than the Brandenburg WWTP meaning, a major expansion at the Brandenburg WWTP would be needed if they were to ever consider serving the industry. After conversations with Monument Chemical, it does not appear imminent that either the City would serve the industry, or the industry would take the City's flows to their plant. As a results, this study does not investigate either option.

Existing agricultural land use is concentrated on three large plots of land within the city limits. The two largest located in the west on Lawrence Street and south on Old State Street account for 17.7% of the city's land usage.

The following table gives the estimated future land use acreages and percentage of total area. Exhibit 2-5 shows these future land use designations. The future land use is based on the city's planning area expanding to include existing water customers that don't currently have sanitary sewer service, as well as potential agricultural and industrial growth in the eastern part of the city. The existing land usage areas remained the same for future land use projections. From the future land use map, Exhibit 2-5, the following table was developed which gives the land use acreages and percentage of total area.

Table 2-2 Brandenburg Future Land Use		
Land Use Designation	**Future Acreage**	**% of Total Area**
Single Family Residential	1,278	29.4%
Two Family Residential	274	6.3%
Multi-Family Residential	185	4.2%
Commercial	765	17.6%
Industrial	359	8.3%
Utilities	37	0.9%
Agriculture	1,455	33.4%
Total Area	**4,185**	**100.0%**

2. Topography and Drainage Patterns

Meade County is located in the Mississippian Plateau, or Pennyroyal Region, of Kentucky. The county is bounded on the north by the Ohio River, on the east and south by Hardin County, and the west by Breckinridge County. Meade Country's terrain is mostly a karst (sinkhole) plain of low relief. The lowest elevation, approximately 383 feet, is the normal pool of the Ohio River. The highest elevation, approximately 1,004 feet, is found on Bee Knob Hill, near Flaherty, Kentucky.

Meade County and the Brandenburg Planning Area are part of the Ohio River Drainage Basin. The Brandenburg Planning Area drains either directly to the Ohio River or drains to Flippins Run which flows directly into the Ohio River. The majority of the Planning Area drains to the Flippins Run – Ohio River watershed (HUC_12 051401041001). The northwest portion of the Planning Area drains to the French Creek – Ohio River watershed (HUC_12 051401041002). The above mentioned watersheds and drainage patterns are shown in Exhibit 2-7.

The existing Brandenburg sanitary sewer collection and treatment systems were originally designed to work with the natural terrain and follow the existing drainage patterns of the area. As the collection system has expanded, the terrain has resulted in numerous lift stations and short force mains being required. The collection system flows from west to east and south to north to the North Main Lift Station, which pumps east to the WWTP. The wastewater treatment plant is located east of downtown Brandenburg approximately 0.36 miles south of its outfall on the Ohio River.

3. Wetlands

The National Wetland Inventory was referenced to determine the presence of wetlands, if any, in the Brandenburg Planning Area. There are several small wetland areas located throughout the Planning Area. The wetlands types included freshwater emergent wetland, freshwater forested/shrub wetland, freshwater pond, and riverine. The majority of the wetlands were freshwater pond. The freshwater ponds are classified as Palustrine Unconsolidated Bottom Permanently flooded. These were found scattered across the entire Planning Area. The second most common wetland type was the freshwater forest/shrub wetland. The forest/shrub wetlands are classified as Palustrine Forested Broad-Leaved Deciduous Temporary, Semipermanently, or Seasonally Flooded. These were found around the forested area along Flippins Run. Identified wetland areas are shown in Exhibit 2-7.

4. 100-Year Floodplain

The FEMA Flood Map Service Center was referenced to determine the extent of the 100-year floodplain of the Ohio River and Flippins Run in relation to both the City of Brandenburg and the Planning Area boundaries. Exhibit 2-8 shows the 100-year floodplain in the Planning Area. As shown on the map, flood hazard areas inundated by the 100-year floodplain are present along the Ohio River and Flippins Run. The floodplain along the Ohio River lies mostly outside the city limits and Planning Area boundaries, but does include portions in the northeast. The flood hazard areas along Flippins Run lies mostly outside of the city except in the northeast. Flippins Run's floodplain does cut across the eastern portion of Planning Area. This area has been designated as future agricultural land use. There does not appear to be significant existing development along either floodplain, with the exception of the North Main Lift Station and Waterfront Park in the northeast part of the City.

5. Surface Water Quality

Referencing the 305 (b) Water Quality Report to Congress (2014), the following streams and lakes in Meade County were listed: Doe Run, Doe Valley Lake, Otter Creek, Wolf Creek, and the Ohio River. Doe Run, Otter Creek, and the Ohio River were found to not support or only partially support one or more of their intended uses. Doe Valley Lake was found to either fully support, or was not assessed for its intended uses. Wolf Creek has not been assessed for its intended uses. In addition, the 303 (d) List of Impaired Waters named Otter Creek, Doe Run, and the Ohio River as impaired streams and as having Total Daily Maximum Loads (TMDLs). Otter Creek and Doe Run's only causes for impairment were fecal coliform. Suspected sources include landfills, livestock, municipal point source discharges, and unspecified urban stormwater. The Ohio River's cause for impairment include Escherichia Coli (E. Coli.), Methylmercury, and Polychlorinated Biphenyls (PCBs). Suspected sources were listed as unknown.

Concerning the stream segments listed as impaired, from the 305 (b) and 303 (d) reports, Doe Run was found to not support primary contact recreation use. Otter Creek was found to only partially support primary contact recreation use. The Ohio River was found to not support primary contact recreation use and only partially support warm water aquatic habitat use and fish consumption.

Currently, the City of Brandenburg's WWTP discharges into the Ohio River (National Hydrography Dataset mile point 643.3).

6. Geology and Groundwater

The Kentucky Geological Survey at the University of Kentucky was referenced for information regarding the geological features and groundwater resources in the Brandenburg Planning Area. Meade County is part of the Mississippian Plateau, or Pennyroyal Region.

The Mississippian Plateau consists of a limestone plain. The plain is characterized by sink holes, sinking streams, streamless valleys, springs, and caverns. The terrain type of the Mississippian Plateau has been defined as Karst Terrain. The thick deposit of Mississippian-age limestone and groundwater has led to the development of the longest cave system in the world, Mammoth Cave-Flint Ridge cave system.

Groundwater is of concern in the Brandenburg Planning Area because it supplies the City with their drinking water, as well as a few domestic water wells. Referencing the Water Treatment Plant Expansion Preliminary Engineering Report (March 2012 - GRW), the three existing wells can produce high iron and magnesium concentrations. These are both monitored and treated at the WTP to stay within the AWWA recommended limits. A fourth well was abandoned due to the presence of ammonia.

7. Water Wells

Water well records for the Planning Area were obtained from the Kentucky Geological Survey. This information shows a number of domestic, monitoring, remediation, industrial, public, and unknown water wells throughout the Planning Area, which are presented in Exhibit 2-7. Additionally, the Water Treatment Plant Expansion Preliminary Engineering Report (March 2012 - GRW) was referenced for information regarding the City's water wells. The wells are located in the Brandenburg Riverfront Park adjacent to the Ohio River and northeast of the downtown area. The city currently has three operating wells providing the main water source to the Brandenburg Water Treatment Plant. A fourth well has been abandoned in the same area. Two of the wells have a capacity of 700 GPM and one has a capacity of 500 GPM. Additionally, there are a few domestic wells in the southwestern portion of the planning area. The wellhead protection areas for the public water wells are also shown on Exhibit 2-7.

8. Soils

A soils map for the Brandenburg Planning Area is shown in Exhibit 2-9. Information for this map was obtained from the NRCS Soil Surveys Geographic Database. The most common types of soils in the Planning Area are: Baxter very gravelly silt loam, karst, 12 to 20 percent slopes, eroded; Hammack-Baxter Complex, karst, 6 to 12 percent slopes, eroded; Baxter very gravelly silty clay loam, karst, 12 to 20 percent slopes, severely eroded; Baxter very gravelly silt loam, karst, 6 to 12 percent slopes, eroded.

Baxter very gravelly silt loam, karst, 12 to 20 percent slopes, eroded (BaD2) soils occur on hills, are well drained, have a depth to water table of greater than 80 inches, and have no frequency of flooding or ponding. This type of soil is not well suited for septic uses due to restricted permeability and steep slopes. It has moderate corrosion characteristics for concrete pipe and has high corrosion characteristics for steel pipe.

Hammock-Baxter complex, karst, 6 to 12 percent slopes, eroded (HbC2) soils occur on ridges, are well drained, have a depth to water table of greater than 80 inches, and have no frequency of flooding or ponding. This type of soil is not well suited for septic uses due to restricted permeability and steep slopes. It has moderate corrosion characteristics for concrete pipe and has high corrosion characteristics for steel pipe.

Baxter very gravelly silty clay loam, karst, 12 to 20 percent slopes, severely eroded (BbD3) soils occur on hills, are well drained, have a depth to water table of more than 80 inches, and have no frequency of flooding or ponding. This type of soil is not well suited for septic uses due to restricted permeability and steep slopes. It has moderate corrosion characteristics for concrete pipe and has high corrosion characteristics for steel pipe.

Baxter very gravelly silt loam, karst, 6 to 12 percent slopes, eroded (BaC2) soils occur on ridges, are well drained, have a depth to water table of 80 inches, and have no frequency of flooding or ponding. This type of soil is not well suited for septic uses due to restricted permeability and steep slopes. It has moderate corrosion characteristics for concrete pipe and has high corrosion characteristics for steel pipe.

9. Plant and Animal Life

There are currently federally listed endangered or threatened species within the Brandenburg Planning Area vicinity. According to the Kentucky Department of Fish and Wildlife, the Gray Bat, Northern Bat, Indiana Bat, and Bullhead Mussel are species on the Federal List of Endangered and Threatened Species that can be found in Meade County. The Gray Bat is listed as threatened, and Northern Bat, Indiana Bat, and Bullhead Mussel are listed as endangered.

The Indiana and Gray Bats live in caves or cave-like habitats and are located in floodplains near rivers or lakes where they feed in the summer. Causes of decline include white-nose syndrome, flooding, the increased use of pesticides on insects, pollution and siltation of streams that have caused a reduction in aquatic insects, and man made changes to cave entrances. The Northern Bats live in old-growth forests for the summer months and caves, mines, and tunnels for hibernation. Causes of decline include white-nose syndrome, loss of mature habitat, and hibernation disturbance. The Bullhead Mussel lives in large rivers and can inhabit medium rivers and reservoirs. Causes of decline include Zebra Mussels, point and non-point source pollution, and habitat destruction due to development.

As selected projects identified in this Facilities Plan are implemented, appropriate measures will be taken to identify, preserve and minimize disturbance to these species in accordance with all applicable State and Federal regulations.

10. Septic Systems

Septic tanks operate through the bacterial breakdown of sewage solids. This breakdown causes the sewage to separate into three layers within the tank: a bottom sludge layer that is slowly digested by bacteria, a middle layer consisting of relatively clear water containing minute particles, and an upper layer consisting of floating solids or scum. Baffles or tees within the tank retain the sludge and scum layers for further treatment and storage, while the middle layer, or clear zone, is discharged to the lateral field for disposal and treatment.

The treatment process's final step is the lateral field, which treats the wastewater by allowing it to trickle down through the soil. As the wastewater percolates to the groundwater below, the filtration process and organisms in the soil work together to clean the effluent. The soil acts as a biological filter to remove bacteria, viruses, and other pollutants from the septic tank effluent. This process can effectively treat the wastewater to acceptable levels that will not contaminate the groundwater. The size and type of lateral field is determined by the anticipated amount of water to be discharged into the system on a daily basis.

The most common system, which can be used on either level land, or moderate slopes with adequate soil depth above the water table/restrictive horizon, is the conventional rock lateral system. The liquid, or effluent, flows from the septic tank through solid piping to one or more distribution boxes, and then into perforated piping within gravel filled trenches. From there, the effluent then seeps into the soil. This conventional "lateral lines" process has a limited application within the Planning Area. In areas where soil doesn't percolate well individuals can consider using recirculating media or mound-type systems.

The Meade County Environmental Services was contacted in April 2017 to discuss the existence and condition of septic tanks in the 1990 Brandenburg Planning Area. The Department did not have knowledge of any specific locations of septic systems within the City proper. The County began keeping records of private septic systems in the mid 1980's. A list of all the County's private septic systems are organized by address. Currently, no general information is known or recorded by Environmental Services about the condition of existing septic systems or straight pipes in Meade County and/or the City of Brandenburg. All existing residents being added to the 2017 Brandenburg Planning Area are assumed to have septic tanks.

11. Drinking Water

The Brandenburg Water System currently serves approximately 1,512 customers. The Water Treatment Plant (WTP) is located on the east side of the City on Trailridge Road. The well field is located north of the WTP in Brandenburg Riverfront Park adjacent to the Ohio River. It consists of three wells with a capacity of 500-700 gallons per minute each that pumps to the WTP through a 12-inch raw water transmission main. The WTP was completed in 1999 and has a rated capacity of 1.0 million gallons per day (MGD), with an average daily pumping demand of approximately 0.76 MGD in 2015. The plant was originally constructed with a chemical building, filter building, a one million gallon clearwell, and a high service and backwash pump station. In 2015, the WTP was upgraded to include the following changes: renovations to various processes of the plant, including demolition of the existing caustic feed process, demolition of the existing gaseous chlorine storage/feed process, and remodeling of all the chemical rooms, including the addition of sodium hypochlorite and sodium permanganate; replacement of the filter media in the process filters; general renovations including painting in the filter building, chemical building and high service pump building; electrical upgrades including a new automatic transfer switch, lightning protection, a new quick connection plug for the portable generator at the well fields, and modifications to the SCADA MTU. The water system currently has a total storage capacity of 1.25 MGD distributed between one clearwell located at the WTP and one elevated storage tank. The tank has a capacity of 250,000 gallon and is located in the City's south side on Old State Road. A new 200,000 gallon elevated water storage tank located on the north side of the City off Lawrence Street (KY 228) is scheduled for completion by mid-2018.

12. Air Quality

The air quality in Brandenburg and Meade County is generally good. The Kentucky Division for Air Quality Fiscal Year 2016 Annual Report was referenced for specific information regarding results in the Brandenburg area, which are discussed below.

The U.S. Environmental Protection Agency Air Quality Index (ARI), which is an index for reporting daily air quality and associated health effects of concern, only has monitors in Jefferson, Bullitt and Hardin Counties in the vicinity of the Planning Area. In 2015, Bullitt and Hardin County had 1-2 days where the ARI was above 100, or in the "Unhealthy for Sensitive Groups" range, and Jefferson County had 8-12 days where the index was above 100.

The Kentucky Division for Air Quality monitors carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, sulfur dioxide, and hazardous air pollutant (toxic) levels at select monitoring locations throughout the state. Again, the only monitors near the Brandenburg Planning Area were in Jefferson, Bullitt and Hardin Counties.

According to the 2016 Report and in reference to the National Ambient Air Quality Standards (NAAQS), the following conclusions were found regarding air quality monitoring results. There were zero exceedances statewide of carbon monoxide, which is only monitored in Jefferson County. There were zero exceedances for lead standards, which is only monitored in Jefferson County. There were zero exceedances statewide of nitrogen dioxide, which is monitored in Jefferson County and a few other counties across Kentucky. Jefferson County was the only county to record a fourth highest daily maximum in exceedance of the eight-hour standard for ozone across the state. Bullitt and Hardin Counties both recorded zero exceedances of ozone. There were zero exceedances statewide of particulate matter. Which is monitored in Jefferson, Hardin, and a number counties across the state. Jefferson County had one exceedance over the daily maximum 1-hour average for sulfur dioxide and was the only site with an exceedance. Sulfur dioxide is monitored across numerous counties in the state. There is only one National Air Toxics Trends Stations (NATTS) monitor in Kentucky to monitor hazardous air pollutants. This monitor is located in Eastern Kentucky, and the results wouldn't be representative of Brandenburg's air quality.

13. Climate

The climate of the Brandenburg Planning Area is temperate and favorable for many kinds of plants and animals with no extreme weather conditions. The Brandenburg area has an annual average temperature of 54.95° F, an annual average high temperature of 66.8° F, and an annual average low temperature of 43.1° F. In general, the summers are warm and humid with average temperatures around 86° F and heat peaking in the month of August. The winters are moderately cold with average temperatures around 24° F and coldest average temperature in the month of January. Snow fall typically occurs between the December 1st and March 1st, with an average annual snowfall of 12.5 inches.

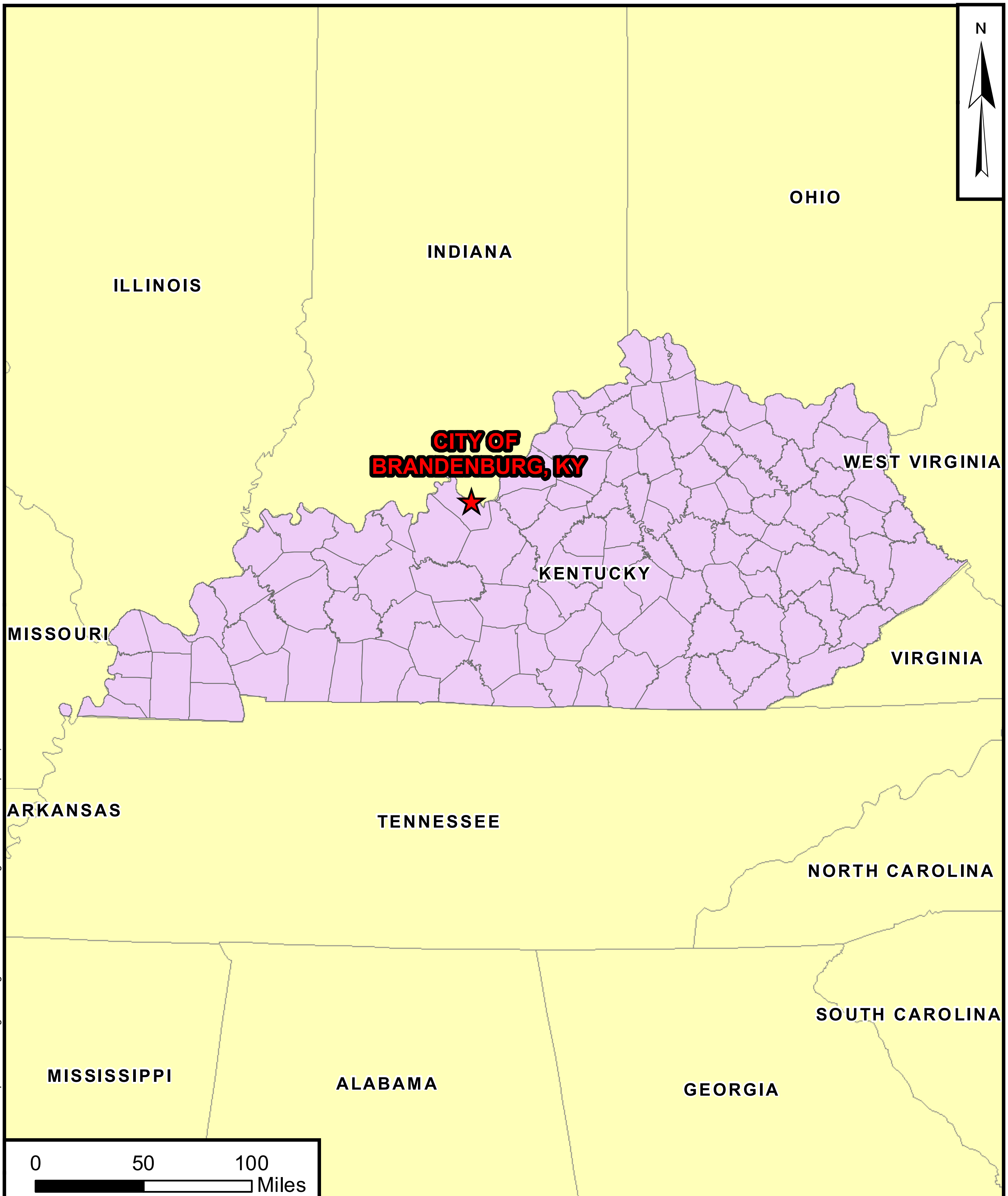
Precipitation is distributed reasonably well throughout the year, with no distinct wet or dry season. Annual precipitation averages about 49-inches. Major droughts are infrequent, but dry periods during the growing season are not uncommon.

14. Historic Sites

The City of Brandenburg was established in 1825 when the Meade County General Assembly authorized Solomon Brandenburg's Landing and Ferry as the seat of justice for Meade County. The town was named after Solomon Brandenburg, who donated the land for the county courthouse. Based on the town's location on the river, Brandenburg prospered as a trade center. The town was also known for Solomon Brandenburg's old log tavern, which hosted John James Audubon, Aaron Burr, and James Wilkinson.

Many historic sites and structures exist in and around the City of Brandenburg. The following sites and structures are listed on the National Register of Historic Places:

- Brandenburg Commercial District, Main St.
- Brandenburg Methodist Episcopal Church, 215 Broadway
- Doe Run Creek Historic District, KY 448
- Doe Run Mill, KY 1638
- Goff-Baskett House, 550 Lawrence St.
- Jones-Willis House, 321 Main St.
- Meade County Clerk Office-Rankin House, 205 Lafayette St.
- Meade County Jail, 125 Main St.
- Richardson House, 547 Lawrence St.
- Yeakel, Edward, House, 116 Decatur St.

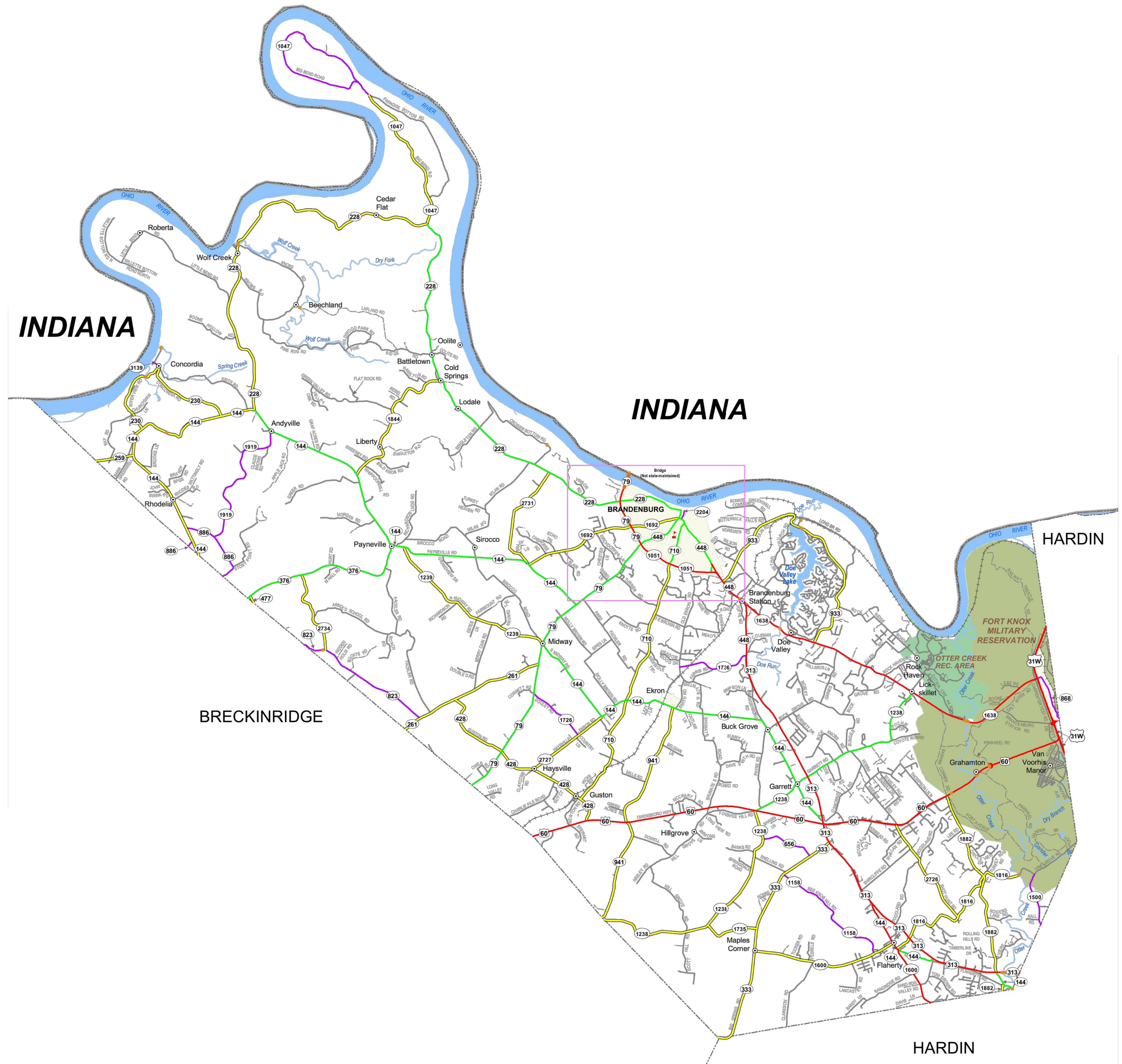


engineering | architecture | geospatial

EXHIBIT 2-1
Wastewater Facilities Plan
Regional Location Map

CITY OF BRANDENBURG, KENTUCKY

Map Document: (G:\4556-Bburg WW Plan\01-WW Plan Update\Working Drawings\GIS\Exhibit 2-1 - Regional Location Map.mxd) 9/13/2017 -- 2:25:48 PM



State Primary Road System

- Interstate
- Parkway
- Other State Primary
- State Secondary
- Rural Secondary
- Supplemental Road
- Unimproved
- Paved or Concrete
- Bridge
- Railroad
- Stream
- City/Town
- Incorporated Area
- Lake
- State Park
- National Park or Recreation Area
- Defense Facility
- Wildlife Area
- Geological Area
- State, National, or Private Forest

EXHIBIT 2-2
MEADE COUNTY MAP

WASTEWATER FACILITIES PLAN
CITY OF BRANDENBURG, KENTUCKY

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FILE NAME: G:\4556-Bburg WW Plan\01-WW Plan Update\Working Drawings\AutoCAD\Exhibit 2-2 - Meade County Map.dwg
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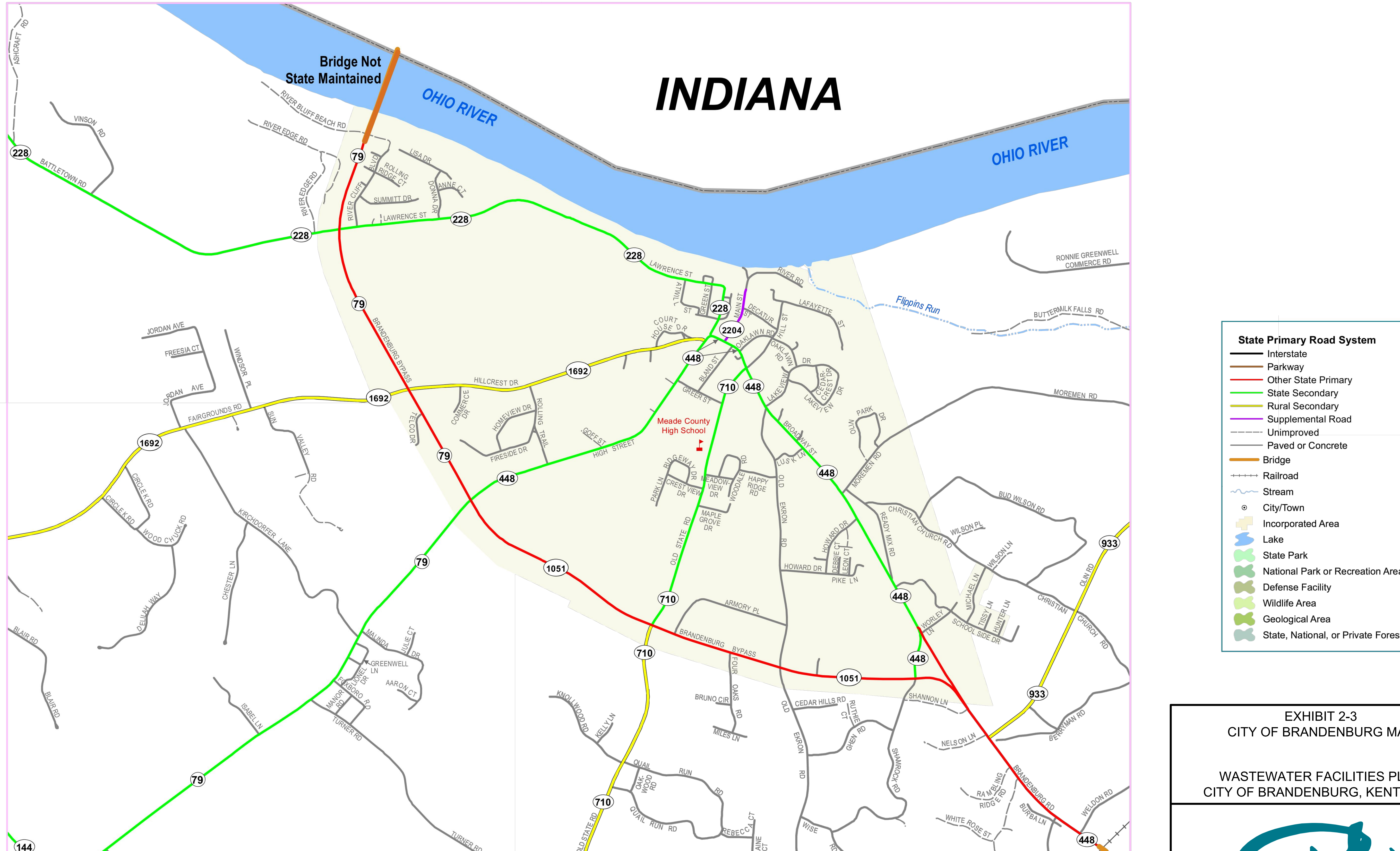

EXHIBIT 2-3
CITY OF BRANDENBURG MAP

WASTEWATER FACILITIES PLAN
CITY OF BRANDENBURG, KENTUCKY

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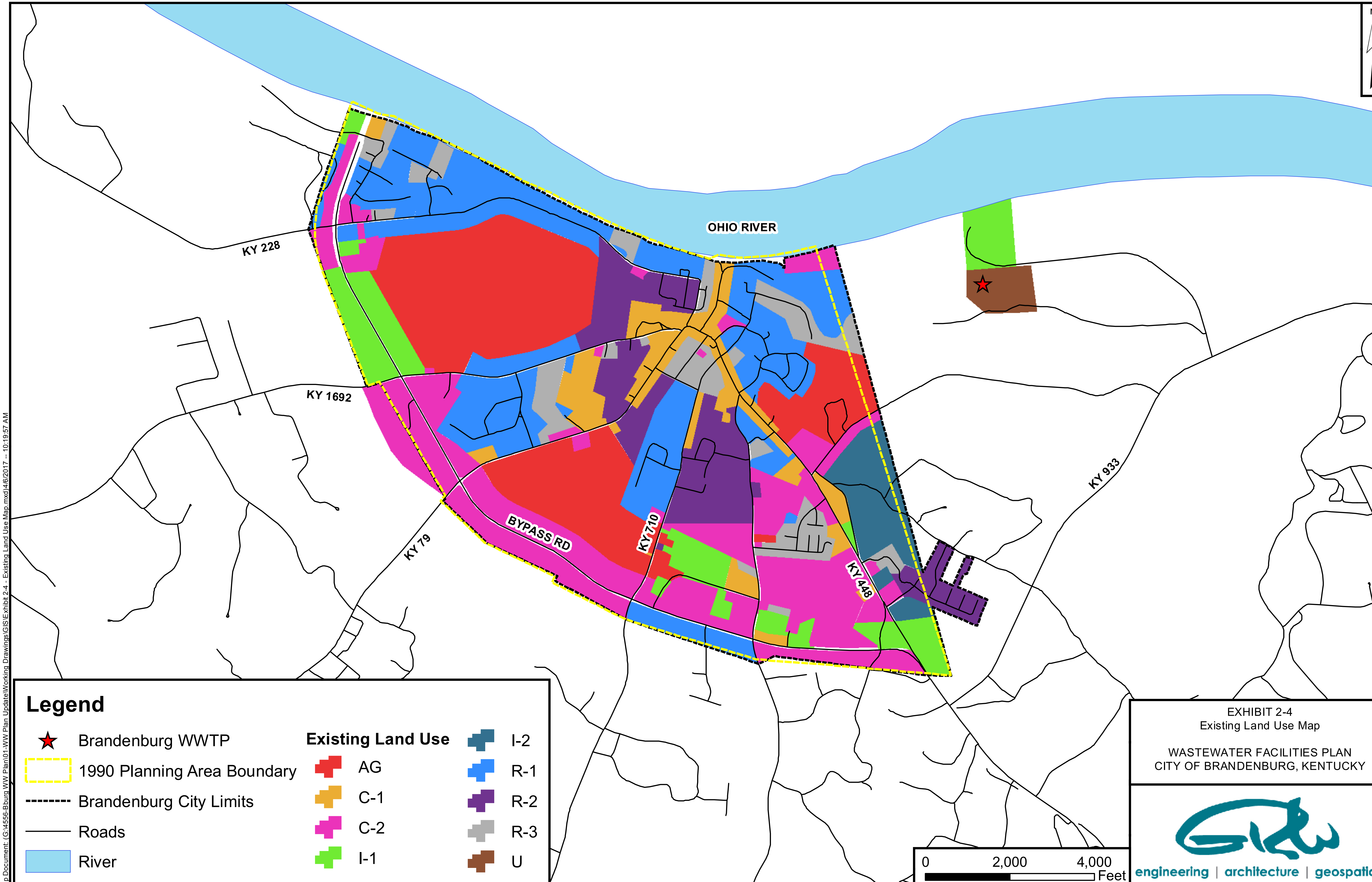

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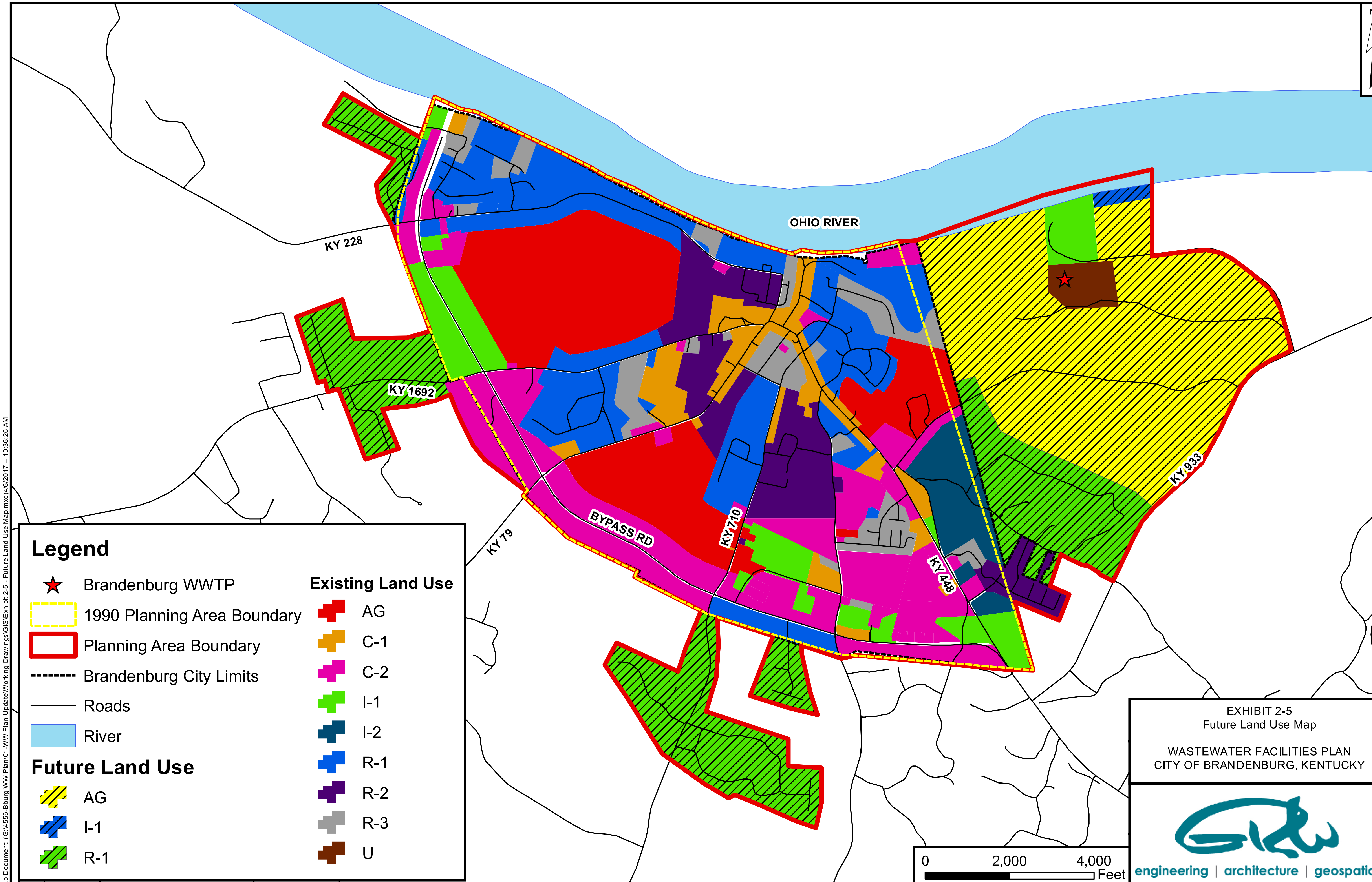

EXHIBIT 2-5
Future Land Use Map

WASTEWATER FACILITIES PLAN
CITY OF BRANDENBURG, KENTUCKY

Map Document: (G:\4556-Bburg WW Plan\01-WW Plan Update\Working Drawings\GIS\Exhibit 2-5 - Future Land Use Map.mxd)4/6/2017 -- 10:36:26 AM

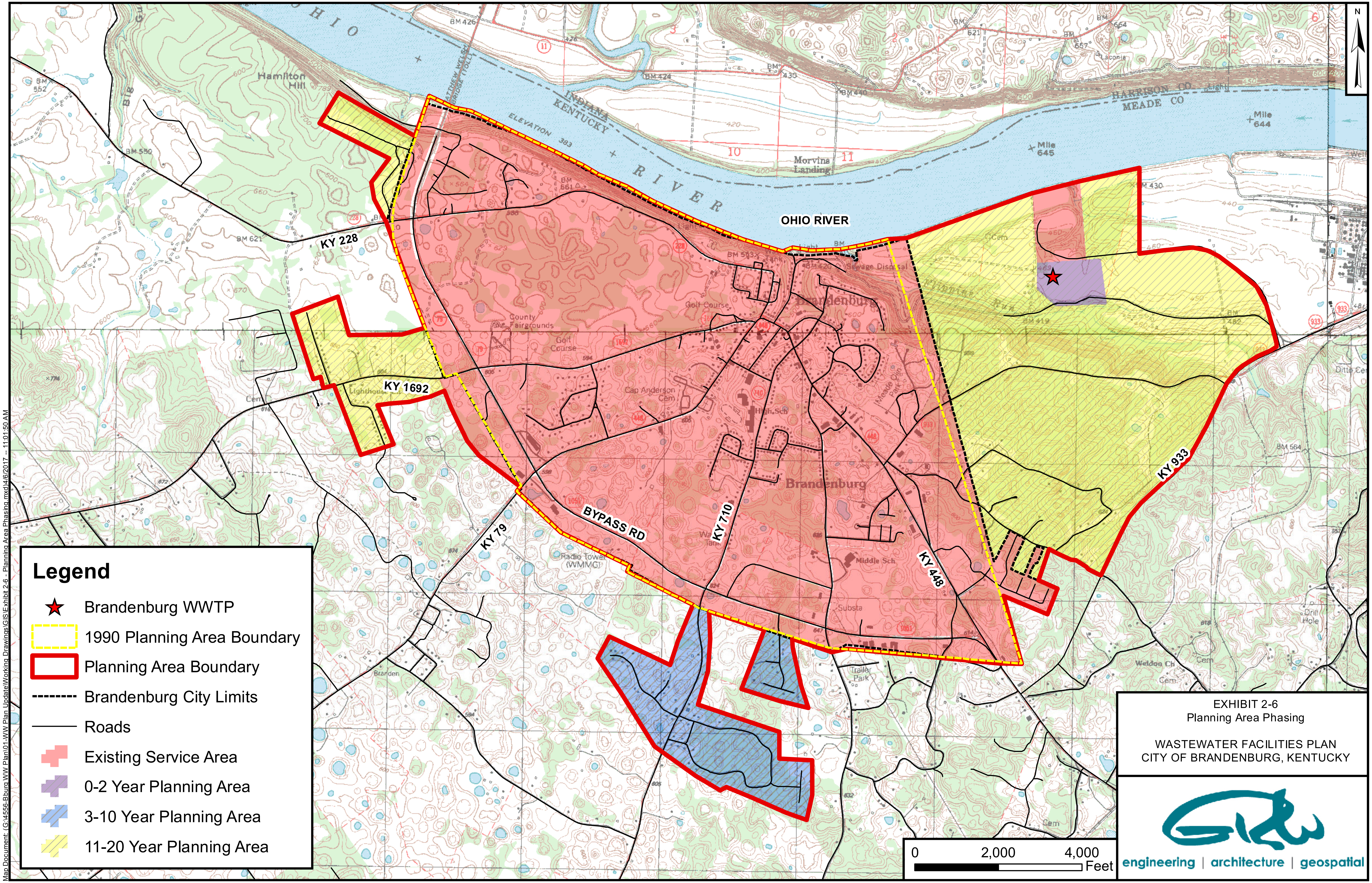

EXHIBIT 2-6
Planning Area Phasing

WASTEWATER FACILITIES PLAN
CITY OF BRANDENBURG, KENTUCKY

Map Document: (G:\4556-Bburg WW Plan\01-WW Plan Update\Working Drawings\GIS\Exhibit 2-6 - Planning Area Phasing.mxd) 4/6/2017 -- 11:01:50 AM

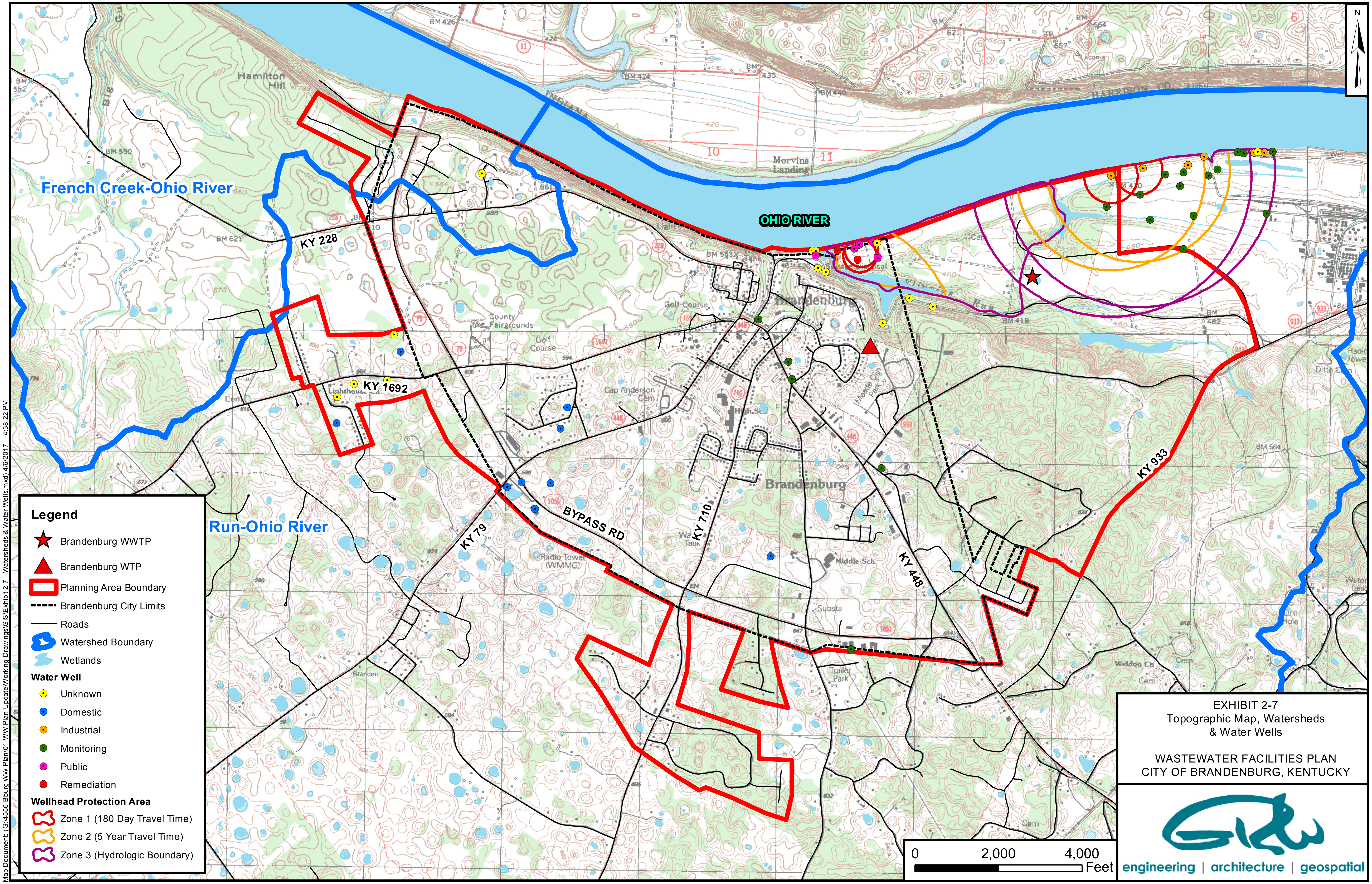

EXHIBIT 2-7
Topographic Map, Watersheds & Water Wells

WASTEWATER FACILITIES PLAN
CITY OF BRANDENBURG, KENTUCKY

Map Document: (G:\4556-Bburg WW Plan\01-WW Plan Update\Working Drawings\GIS\Exhibit 2-7 - Watersheds & Water Wells.mxd) 4/6/2017 -- 4:38:22 PM

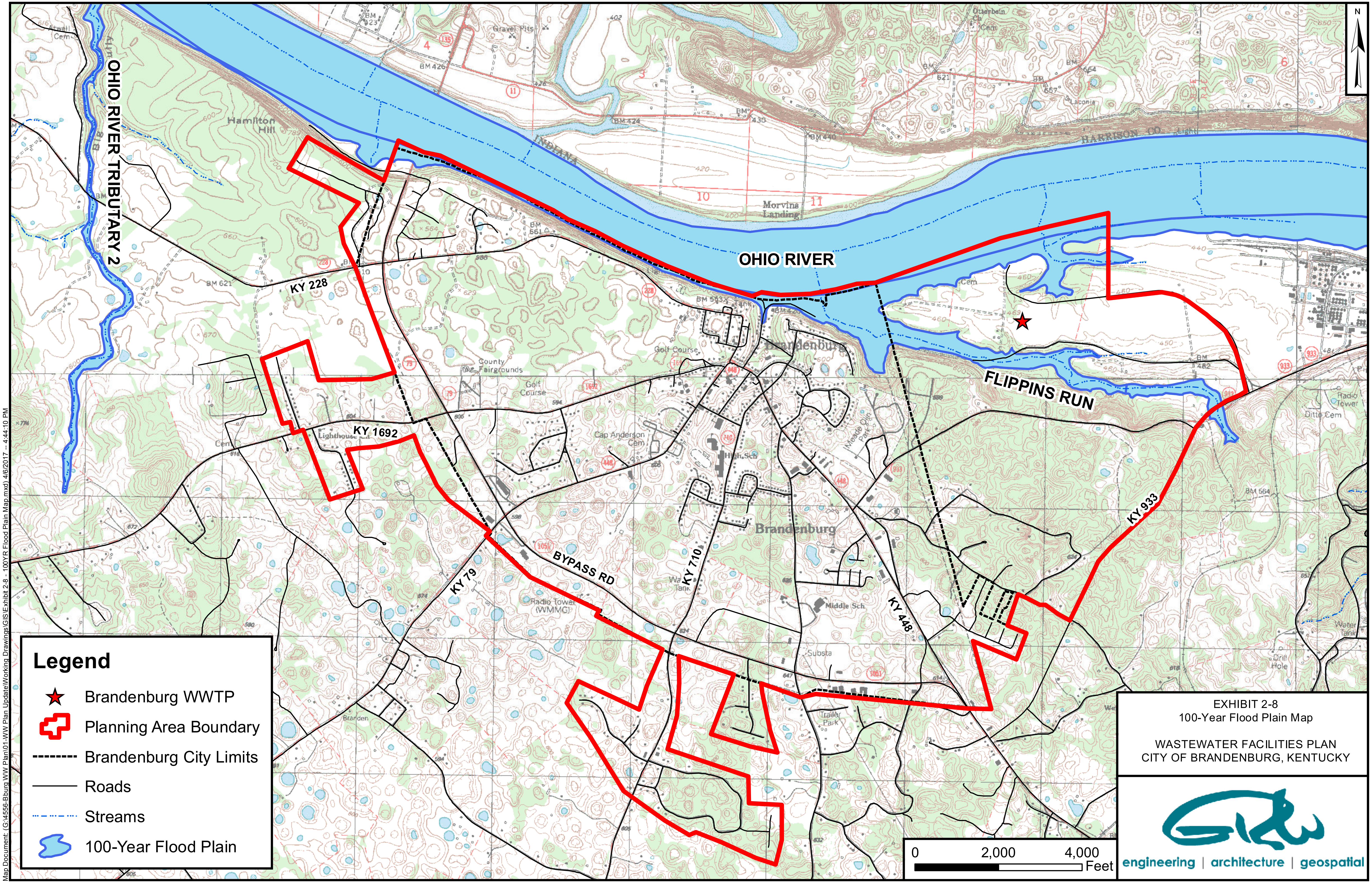

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EXHIBIT 2-9
Soil Survey Map

WASTEWATER FACILITIES PLAN
CITY OF BRANDENBURG, KENTUCKY

Map Document: (G:\4556-Bburg WW Plan\01-WW Plan Update\Working Drawings\GIS\Exhibit 2-9 - Soil Survey Map.mxd) 4/6/2017 -- 4:55:29 PM

Chapter 3
Socioeconomic Characteristics of the Planning Area

A. Purpose

The purpose of this chapter is to project population growth in the Brandenburg Planning Area for the period from 2017 to 2037. Population projections are important, as estimated flows for the wastewater collection system and treatment plant are based on the population served. A completely accurate procedure to develop long-term population projections does not exist, as factors such as changes in economic development can alter long-range estimates. The standard procedure for projecting population estimates is to review past population growth patterns for the area in question and utilize these patterns, along with expected land use designations and specific development knowledge, to project future growth.

The current socioeconomic conditions, labor force, income, educational facilities, community facilities, housing, and transportation and access are also presented.

B. Population Trends

The 2010 U.S. Census reported a population of 2,643 for the City of Brandenburg. The 2010 Brandenburg population predicted by the 1990 Brandenburg Wastewater Facilities Plan was 2,431, so the City has actually grown at a quicker rate than was predicted in 1990.

Annual population estimates for the State of Kentucky, Meade County, and the City of Brandenburg for the years 2011 to 2015, were obtained from the U.S. Census Bureau Population Division via the Kentucky State Data Center. The Kentucky State Data Center has also issued population projections for five-year intervals at the State and County level through the year 2040. The 2010 Census population data, the annual population estimates, and the five-year population projections were used to develop Kentucky, Meade County and Brandenburg population projections for each year through 2040.

The estimates for the years between the five-year population projections were interpolated with each year growing by the same number of people. The population estimates for the City of Brandenburg beyond the 2015 estimate by the State Data Center were determined by applying the growth percentages for Meade County to the City through 2037, which assumes that Brandenburg will grow at the same rate as the county for this time period. The population projections are provided in Exhibit 3-1.

C. Labor Force

According to U.S. Census data, 58.8% of Brandenburg's population 16 and over was in the labor force in 2010, of which 19.3% were unemployed. Based on 2015 U.S. Census data estimates, 58.3% of the City's population 16 and over was in the labor force, of which 18.2% were unemployed. The unemployment rates for the State of Kentucky were 8.2% and 8.4% in 2010 and 2015, respectively.

The City's civilian labor force was estimated as 1,061 persons by the U.S. Census Bureau for 2015. The top five employment classifications for the City of Brandenburg, according to 2015 estimates are:

- Educational services, and heath care and social assistance (27.7%)
- Arts, entertainment, and recreation, and accommodation and food services (15.3%)
- Retail Trade (9.8%)
- Professional, scientific, and management, and administrative and waste management services (9.3%)
- Manufacturing (8.4%)

D. *Income*

The City of Brandenburg's per capita and median household income estimates by the 2015 U.S. Census data were $19,316 and $38,243, respectively. These compare to $24,063 and $43,740 median household income for the State of Kentucky from the same Census estimates. Both values are lower for the City than the State.

Also from the 2015 U.S. Census estimates, 21.8% of families and 28.0% of people were estimated to be living below the poverty level in the City of Brandenburg. This compares to 14.4% of families and 18.9% of people living below the poverty level for the State of Kentucky. The City of Brandenburg has a higher poverty percentage in both categories compared to the State of Kentucky.

E. *Educational Facilities*

The public schools in the City of Brandenburg are part of the Meade County Schools system. There are eight schools in total: two primary, four elementary, one middle, and one high school. Four Meade County Schools are located within Brandenburg's city limits are Brandenburg Primary, David T. Wilson Elementary, Stuart Pepper Middle School, and Meade County High School. In addition to the four public schools, the City of Brandenburg also has one private school, St. John The Apostle School, and one technology center, Meade County Area Technology Center.

F. *Community Facilities*

Government offices and facilities for Meade County are located in the City of Brandenburg, the county seat. The Meade County Courthouse, located on Hillcrest Drive, houses offices of the county judge/executive, county court clerk, county attorney, vehicle registration, and jail. The Meade County chamber of commerce, PVA, road department garage, solid waste department, board of education, water district, public library, and fire protection district are also located within the city limits.

There are two city parks located in Brandenburg; Meade-Olin Park located in the eastern part of the City on Moremen Road, and Brandenburg Riverfront Park located in the northern part of the City on River Road. Meade-Olin Park includes tennis courts, ball fields, soccer field, basketball courts, disc golf, picnic areas, shelter area, and playground. Brandenburg Riverfront Park, located on the Ohio River, includes boat ramps, picnic areas, soccer fields, two pavilions, playground, checkers/chess table, amphitheater, and a gazebo.

Commercial facilities include the Meade County Activities Center and Lynn's Pins. The Meade County Activities Center includes a fitness center, 9-holf golf course, driving range, putting/chipping green, pool, and tennis courts.

In addition, the Otter Creek Outdoor Recreation Area is located within 20 minutes of the City of Brandenburg. Otter Creek is a 3,600-acre woodland with 24-unit lodges, 165 campsites, horseback riding, hiking trails, tennis, basketball, volleyball, a playground, and picnic pavilions.

G. *Housing*

The 2015 U.S. Census data reported that there were 1,292 housing units in the City of Brandenburg. Of those, 1,068, or 82.7% of total units were occupied and 224, or 17.3%, of the total units were vacant. Rental property made up 52.6% of the total occupied housing units. This compares to 87.9% total units occupied and rental property making up 32.8% of total occupied housing units in the State of Kentucky. The City of Brandenburg has a higher vacancy and rental property percentage compared to the State.

The City's median house value in 2015 was $120,700 for owner occupied units. The median rent for renter occupied units in the City was $602. Both of these statistics are comparable to the State of Kentucky's median house value of $123,200 and median rent value of $675 for the same census estimate.

H. *Transportation and Access*

The City of Brandenburg is accessible from Corydon, IN to the north via I-64 and IN-135, from Fort Knox, KY to the east via US 31W and

KY-1638, from Irvington, KY to the south via US 60 and KY-79, and from Payneville, KY to the west via KY-144 and KY-79.

The nearest private air service to the City of Brandenburg is provided at Breckinridge County Airport, which is located approximately 29 miles to the south. The nearest scheduled commercial air service is provided at the Louisville International Airport, which is located approximately 50 miles northeast of Brandenburg.

The Ohio River borders the City of Brandenburg and Meade County to the north. Public boat ramps can be found at the Brandenburg Riverfront Park located on the northern side of the City.

I. ***Economic and Social Benefit to the Community***

The availability of a well operated and maintained wastewater system, with available capacity that allows for the community's project growth during the next 20 years, provides the backbone for economic growth and development. When combined with the implementation of other infrastructure and social projects, the Wastewater Facilities Plan establishes a means to attract new businesses to the Planning Area, which in turn equates to improved socioeconomic conditions and to an environment that supports expanded residential growth.

Exhibit 3-1

Kentucky, Meade County, and City of Brandenburg Population Esimates and Projections

Year	Kentucky		Meade County*		City of Brandenburg	
	Population	% Change	Population	% Change	Population	% Change
1990	3,685,296 [1]		24,170 [1]		1,857 [1]	
		8.82%		8.27%		9.37%
2000	4,041,769 [1]		26,349 [1]		2,049 [1]	
		6.86%		7.88%		22.47%
2010	4,339,367 [1]		28,602 [1]		2,643 [1]	
		0.65%		3.63%		5.84%
2011	4,367,882 [2]		29,679 [2]		2,807 [2]	
		0.34%		-1.28%		0.85%
2012	4,382,667 [2]		29,305 [2]		2,831 [2]	
		0.36%		0.05%		1.80%
2013	4,398,500 [2]		29,320 [2]		2,883 [2]	
		0.32%		-0.21%		1.60%
2014	4,412,617 [2]		29,260 [2]		2,930 [2]	
		0.28%		-4.78%		-2.73%
2015	4,425,092 [2]		27,924 [2]		2,852 [2]	
		0.49%		-0.38%		-0.38%
2016	4,446,766 [4]		27,818 [4]		2,841 [5]	
		0.49%		-0.38%		-0.38%
2017	4,468,441 [4]		27,712 [4]		2,830 [5]	
		0.48%		-0.38%		-0.38%
2018	4,490,115 [4]		27,607 [4]		2,819 [5]	
		0.48%		-0.38%		-0.39%
2019	4,511,790 [4]		27,501 [4]		2,809 [5]	
		0.48%		-0.39%		-0.39%
2020	4,533,464 [3]		27,395 [3]		2,798 [5]	
		0.44%		-0.45%		-0.45%
2021	4,553,654 [4]		27,272 [4]		2,785 [5]	
		0.44%		-0.45%		-0.46%
2022	4,573,844 [4]		27,149 [4]		2,773 [5]	
		0.44%		-0.46%		-0.46%
2023	4,594,035 [4]		27,026 [4]		2,760 [5]	
		0.44%		-0.46%		-0.46%
2024	4,614,225 [4]		26,903 [4]		2,747 [5]	
		0.44%		-0.46%		-0.46%
2025	4,634,415 [3]		26,780 [3]		2,735 [5]	
		0.40%		-0.57%		-0.57%
2026	4,652,808 [4]		26,629 [4]		2,719 [5]	
		0.39%		-0.57%		-0.57%
2027	4,671,202 [4]		26,478 [4]		2,704 [5]	
		0.39%		-0.57%		-0.58%
2028	4,689,595 [4]		26,327 [4]		2,688 [5]	
		0.39%		-0.58%		-0.58%
2029	4,707,989 [4]		26,176 [4]		2,673 [5]	
		0.39%		-0.58%		-0.58%
2030	4,726,382 [3]		26,025 [3]		2,657 [5]	
		0.35%		-0.69%		-0.70%
2031	4,742,842 [4]		25,845 [4]		2,639 [5]	
		0.35%		-0.70%		-0.70%
2032	4,759,302 [4]		25,666 [4]		2,620 [5]	
		0.34%		-0.70%		-0.71%
2033	4,775,762 [4]		25,486 [4]		2,602 [5]	
		0.34%		-0.71%		-0.71%
2034	4,792,222 [4]		25,307 [4]		2,583 [5]	
		0.34%		-0.71%		-0.72%
2035	4,808,682 [3]		25,127 [3]		2,565 [5]	
		0.32%		-0.85%		-0.86%
2036	4,824,222 [4]		24,915 [4]		2,543 [5]	
		0.32%		-0.86%		-0.86%
2037	4,839,762 [4]		24,703 [4]		2,521 [5]	

* Meade County population estimates and projections include City of Brandenburg's population

[1] 1990, 2000, 2010 Census Data, U.S. Census Bureau

[2] Annual State and County Population Estimates, Population Division, U.S. Census Bureau, as of January 1, 2015

[3] Population Projections 2015 - 2040, Kentucky State Data Center, University of Louisville, Vintage 2016

[4] Interpolated

[5] Extrapolated from Meade County projected growth rates

Chapter 4
Wastewater Flows and Characteristics

A. Purpose

The purpose of this chapter is to project the flows and characteristics of wastewater generated within the Planning Area for the Planning Period from 2017 through 2037. These flow rates and characteristics will be used in the design of wastewater collection and treatment systems upgrades to meet Kentucky Pollutant Discharge Elimination System (KPDES) permit requirements and discharge limitations throughout the Planning Period. This chapter details the existing and projected wastewater flows and characteristics.

B. Existing Wastewater Flows

Wastewater in the City of Brandenburg is treated at the Brandenburg WWTP, which is located east of the city limits. The Brandenburg WWTP currently has a rated average daily treatment capacity of 0.312 million gallons per day (MGD) and a peak hydraulic capacity of 0.932 MGD.

The average daily flow (ADF) to the Brandenburg WWTP over the last three years (January 2014 through December 2016) is 0.232 MGD and the peak day flow (PDF) over the same time period was 0.752 MGD in February 2016.

ADF and peak day flows for the last three years are provided in Table 4-1 and plant performance data for the same time period is tabulated in Exhibit 4-1.

Table 4-1
Average and Peak Day Flows
Brandenburg WWTP

Year	Average Daily Flow (MGD)	Peak Day Flow (MGD)
2014	0.223	0.634
2015	0.233	0.588
2016	0.239	0.752

C. Industrial Dischargers

Monument Chemical is the only industrial discharger located near Brandenburg's Planning Area. Monument Chemical has its own 9.34 MGD on-site treatment plant (KPDES Permit No. KY0002119), which does not discharge to Brandenburg's WWTP. As a result, there are no industrial discharges to the City's Collection System.

D. Projected Wastewater Flows

In December 2016, Brandenburg had approximately 1,391 sewer customers. The total population served by the sewer system is estimated to be approximately 2,841. The approximate number of sewer customers were based on information provided by City staff. The estimated population served was extrapolated from the 2015 population estimate (Census Bureau, American FactFinder, Community Facts, Population Estimate Program) and Meade County population growth rate (University of Louisville, Kentucky State Data Center). Taking the average daily flow of 0.232 MGD (2014 through 2016) and dividing it by the total system customers gives an average flow per customer of 166.5 GPD. This number takes into account all classes of customer. The average flow per customer was then used to calculate future flows for the existing service area, while land use maps were used to calculate future flows for expansion areas.

Exhibit 4-2, Wastewater Flow Projections, contains the flow rates projected from the present through 2037 (the end of the Planning Period). The average wastewater flow per day for the year 2037 is estimated to be 0.268 million gallons. The peaking factor is 1.64 based on the historical peaking factor (2014 through 2016). As a result, the peak hourly flow has been estimated at 0.439 million gallons per day. Therefore, for the purpose of this study, the 20-year projected average daily flow for the Planning Area is 0.268 million gallons per day. The 20-year projected peak hydraulic flow, using a peaking factor of 1.64, is approximately 0.439 million gallons per day.

Exhibit 4-2 shows the projected flow rates broken down into several components. The following is a description of the manner in which each of those components was calculated:

1. Average Wastewater Flow (Existing Service Area)

The flow component for the existing service area was calculated using population projections from the Kentucky State Data Center at the University of Louisville. The projected number of sewer customers was calculated by applying the projected population growth to the number of sewer customers as provided by the City. As stated previously, the Brandenburg wastewater system served approximately 1,391 customers as of December 2016.

The average flow per customer of 166.5 GPCD has increased since the 1990 Facilities Plan, which had an average flow per customer of 133 GPCD. This shows that there has potentially been an increase in inflow and infiltration (I & I) since the 1990 Facilities Plan. An increase in I & I isn't uncommon when a system has aging vitrified clay piping.

2. Expansion Areas

Based on meetings with the Brandenburg Mayor and City Staff, a future land use map was developed (see Future Land Use Map in Exhibit 2-5). The projected wastewater flows in the expansion area were calculated using the Louisville and Jefferson County Metropolitan Sewer District's (MSD's) Design Manual. The suggested flows for agricultural, industrial, and residential land use are 0, 1,000, and 400 gallons per acre per day, respectively. However, since the residential expansion area includes existing residential neighborhoods the 400 gallons per acre per day was not applied. Instead, the existing houses were counted within each area and the average flow per customer of 166.5 GPCD was applied to each house to develop the future wastewater flows. Table 4-2 shown below summarizes the additional future land use wastewater flows.

Table 4-2
Future Land Use
20-Year Wastewater Flow Projections

Land Use Designation	Acre	Avg Gal/ Acre/Day
Agriculture	862	0
Industrial	20	20,000
Land Use Designation	**Homes**	**Avg Gal/ Homes/Day**
Single Family Residential	252	41,955

a. Expansion Area No. 1 (0-2 Year Development)

The City of Brandenburg doesn't have any planned expansion for the 0-2 year development period. During the 0-2 year development period, the City intends to upgrade the Brandenburg WWTP based on the recommendations herein.

b. Expansion Area No. 2 (3-10 Year Development)

Expansion Area No. 2 consists of two existing neighborhoods, and is located south of the existing service area (see Exhibit 2-6 for Planning Area Phasing). One neighborhood is located along Four Oaks Road and Miles Lane off By Pass Road. The second neighborhood is along Quail Run Road, Oakwood Drive, Rebecca Court, Blaine Court, Knollwood Road, and Kelly Lane off Old State Road. This area currently has 105 homes on Brandenburg's water system and all homes are assumed to be on septic tanks. Land use in Expansion Area No. 2 is projected as follows (also see Exhibit 2-5):

Table 4-3 Expansion Area No. 2 (3-10 Year) Future Land Use		
Land Use Designation	**Future Acreage**	**# of Homes**
Single Family Residential	266	105

The projected average daily flow for Expansion Area No. 2 is approximately 17,481 GPD (see Exhibit 4-2). For the purpose of projections, the total expansion area flow is distributed evenly over the development period of 3-10 years.

c. Expansion Area No. 3 (11-20 Year Development)

Expansion Area No. 3 is the largest expansion area consisting of residential, agricultural, and industrial development (see Exhibit 2-5 for Planning Area Boundary and Phases). On the western side of the area, two existing neighborhoods are being added to the service area. One neighborhood is located along Fairgrounds Road, Sun Valley Road, and Windsor Place off By Pass Road. The second neighborhood is located along River Edge Drive and River Edge Road off Battletown Road. This area has 82 homes that are currently on Brandenburg's water system, and all homes are assumed to be on septic tanks. On the eastern side of the service area, one existing neighborhood and future agricultural and industrial development are being added to the service area. The existing neighborhood is located along Christian Church Road, Bud Wilson Road, and Wilson Place off KY 933. This area currently has 65 homes on Brandenburg's water system, and all homes are assumed to be on septic tanks. The large agricultural development area starts on the eastern edge of the existing service and goes east to KY 933 and from the Ohio River south to the neighborhood described above. The industrial development area starts on the eastern edge of the existing Consolidated Grain and Barge (CGB) company property east and from the Ohio River south to the private access road to the CGB.

Land use in Expansion Area No. 3 is projected as follows (also see Exhibit 2-5):

Table 4-4 Expansion Area No. 3 (11-20 Year) Future Land Use		
Land Use Designation	**Future Acreage**	**% of Total Area**
Agriculture	826	64.8%
Industrial	20	1.6%
Single Family Residential	428	33.6%
Total Area	**1,274**	**100.0%**

The projected average daily flow for Expansion Area No. 3 is approximately 44,474 GPD (see Exhibit 4-2). For the purpose of projections, the total expansion area flow is distributed evenly over the development period of 11-20 years.

E. *Wastewater Characteristics*

Raw wastewater strengths for five-day biochemical oxygen demand (BOD_5) and total suspended solids (TSS) at the Brandenburg WWTP are summarized for the time period from 2014 through 2016 in Exhibit 4-1. The average influent BOD_5 and TSS values between 2014 and 2016 were 401 mg/l (783 lbs/day) and 371 mg/l (716 lbs/day), respectively. The plant's design loading capacities are 870 lbs/day BOD_5 and 840 lbs/day TSS. Neither value currently exceeds the plant design capacity. However, the influent concentrations for BOD_5 and TSS exceed the projected concentrations within the O&M manual. The plant's design removal efficiencies for BOD_5 and TSS are both 90%, respectively, while are average removal efficiency between 2014 and 2016 for BOD_5 and TSS are 96.7% and 90.4%, respectively. These two averages meet the design criteria of the WWTP of 90% removal for both TSS and BOD. During the last three years, there were 10 months (28% of data) when the TSS removal efficiency was below the 90% design criteria with the lowest percentage at 65% in January 2016. During the last three years, there was only one month (June 2014) when the BOD removal didn't meet the 90% design criteria with a removal percentage of 87.6%. The potential causes for the poor TSS of removal efficiency will be discussed in more detail later in this plan.

The following are the projected waste loads for the Brandenburg WWTP for the planning period:

Table 4-5 Brandenburg WWTP Projected Influent Waste Loads (2037)		
Service Area	**BOD_5 (lbs/day)**	**TSS (lbs/day)**
Existing	783	716
Expansion Area No. 1	-	-
Expansion Area No. 2	36	43
Expansion Area No. 3	85	100
Total	**904**	**859**

Influent ammonia and phosphorus concentrations aren't measured at Brandenburg's WWTP. The effluent ammonia and phosphorus concentrations for time period between 2014 through 2016 averaged 10.87 mg/l and 6.31 mg/l, respectively. Brandenburg's WWTP is not anticipated to receive a phosphorous limit due to their discharge being on the Ohio River. Ammonia removal is typically an issue during cold weather, which is often times an issue in these types of plants.

The existing service area waste loads were based on the historic average waste loads (2014-2016). For the non-industrial waste loadings in the expansion area, 0.17 lbs BOD_5/population equivalent/day and 0.20 lbs TSS/population equivalent/day were used per Paragraph 11.253 of Ten State Standards. For industrial waste loads in the expansion areas, it was assumed that any future industrial development would only be disposing of domestic waste to Brandenburg's WWTP. A population equivalent of 10 persons per acre and the Ten State Standards for non-industrial waste loading was used to develop the industrial waste loadings.

The historic influent BOD and TSS concentrations are higher than expect for a City like Brandenburg. These high concentrations could potentially be caused by poor food preparation and disposal practices at the local schools and restaurants. Using language found in their Sewer Use Ordinance (see Appendix N for Brandenburg's Sewer Use Ordinance), as well as, other sources the City will try to approach resolving the high influent BOD and TSS concentrations through public outreach and education.

Therefore, the 2037 projected waste loads to the Brandenburg WWTP are 904 lbs/day (404 mg/l) BOD_5, and 859 lbs/day (384 mg/l) TSS, which are slightly higher than the plants current rated values.

F. Projected 2037 Influent Data

The projected 2037 influent data that were presented earlier in this chapter are summarized in Table 4-6.

Table 4-6 Projected 2037 Influent Data Summary	
Parameter	**Value**
Average Day Flow (MGD)	0.268
Peak Hourly Flow (MGD)	0.439
BOD_5 Concentration (mg/l)	404
BOD_5 Loading (lbs/day)	904
TSS Concentration (mg/l)	384
TSS Loading (lbs/day)	859

The existing average design flow for the WWTP is 0.312 MGD. The selected treatment alternative will be designed to have the same average design flow. Based on a 0.312 MGD average design flow, the following are the 2037 influent design parameters:

Table 4-7 2037 Brandenburg WWTP Influent Design Parameters	
Influent Parameter	**Value**
Average Daily Flow	0.312 MGD
Peak Hydraulic Flow	0.932 MGD
BOD_5	1052 lbs/day
BOD_5	404 mg/l
TSS	1000 lbs/day
TSS	384 mg/l
Ammonia-Nitrogen	70 lbs/day*
Ammonia-Nitrogen	27 mg/l*

*Based on the original WWTP design. It is recommended that the City begin sampling influent ammonia-nitrogen to determine if this value has changed. If so, the design will be adjusted accordingly.

G. *Inflow and Infiltration*

Infiltration is defined by the Water Environment Association (WEA) in their Manual of Practice FD-6, *Existing Sewer Evaluation & Rehabilitation* as "the water entering a sewer system and service connections from the ground, through such means as, but not limited to, defective pipes, pipe joints, connections, or manhole wall". Additionally, "infiltration does not include, and is distinguished from inflow".

Inflow is defined by FD-6 as "the water discharged into a sewer system and service connections from such sources as, but not limited to, roof leaders, cellar, yard and area drains, foundation drains, cooling water discharges, drains from springs and swampy areas, manhole covers, cross connections from storm and combined sewers, catch basins, storm water, surface runoff, street washes, or drainage. Additionally, it "does not include, and is distinguished from infiltration".

The Kentucky Division of Water has established the following guidelines for the recommendation of a sanitary sewer study:

1. Receive more than 275 gallons per capita per day of sewage flow based on the maximum flow received during a twenty-four (24) hour period exclusive of industrial flow; or

2. Receive more than 120 gallons per capita per day of sewage flow based on the annual average of daily flows exclusive of industrial flow.

Following is a calculation of the maximum and average daily flow per capita for the previous 36 month period (January 2014 through December 2016).

Average Daily Flow = 0.232 MGD

Maximum Daily Flow (24 hour period) = 0.752 MGD

Approximate Population Served = 2,841

Average Per Capita Flow = 81.66 GPCD

Max Daily Per Capita Flow = 264.70 GPCD

The average and maximum per capita flows are both below the DOW guidelines. Additional, the peak factor ranges from 1.09 to 3.00 in the period of time from 2014 through 2016, with an average of 1.64. This is another indicator that the City's collection system is not experiencing severe I&I issues.

Based solely on the calculations above, the City's collection system is not showing severe signs of I&I. However, based on the majority of the system being 55+ year old vitrified clay pipe, it would be recommended that the City establish a CCTV program. This would allow the City to visually confirm that their collection system remains intact, as well as provide a systematic approach to correcting issues as they are discovered.

Exhibit 4-1
Performance Characteristics
City of Brandenburg Wastewater Treatment Plant

Year	Month	Influent Flow			Eff Flow	Influent TSS			Effluent TSS			TSS % Removal	Influent BOD			Effluent BOD			BOD % Removal	Effluent PH		Effluent NH_3N	Effluent Phosphorous	Effluent DO	Effluent E. Coli.
		AVG	MAX	Peak Factor	AVG	AVG	MAX	AVG	AVG	MAX	AVG		AVG	MAX	AVG	AVG	MAX	AVG		MAX	MIN	AVG	AVG	AVG	AVG
		(MGD)			(MGD)	(mg/l)		(lbs/day)	(mg/l)		(lbs/day)		(mg/l)		(lbs/day)	(mg/l)		(lbs/day)		(SU)		(mg/l)	(mg/l)	(mg/l)	(#/100ml)
2014	January	0.220	0.357	1.63	0.170	218	535	400	64	90	90	77.5%	305	416	558	28	37	39	93.0%	8.48	6.94	23.88	5.89	10.2	1
2014	February	0.240	0.337	1.40	0.192	680	2065	1362	56	58	89	93.4%	372	763	746	19	26	31	95.9%	7.68	6.74	29.65	5.55	7.8	1
2014	March	0.220	0.256	1.16	0.175	156	348	287	53	68	78	73.0%	320	381	588	23	26	33	94.4%	7.12	6.97	34.98	6.75	7.3	1
2014	April	0.240	0.634	2.64	0.215	520	1540	1042	55	69	100	90.4%	375	810	752	33	49	60	92.0%	7.67	7.16	32.22	6.68	8.0	74
2014	May	0.217	0.314	1.45	0.191	298	518	540	62	76	98	81.8%	327	377	593	34	46	53	91.0%	7.35	6.81	33.00	7.02	6.6	1
2014	June	0.209	0.228	1.09	0.166	301	703	524	83	112	114	78.2%	446	669	777	69	84	96	87.6%	6.98	6.50	27.13	8.07	5.8	1
2014	July	0.231	0.315	1.36	0.170	1825	7380	3512	40	68	57	98.4%	510	1519	982	30	71	43	95.6%	8.74	6.36	19.42	6.33	7.1	1
2014	August	0.242	0.283	1.17	0.190	688	1895	1390	21	33	34	97.6%	375	688	758	27	79	42	94.4%	8.59	6.79	0.95	5.75	9.0	4
2014	September	0.230	0.288	1.25	0.177	521	1640	999	21	30	32	96.8%	228	286	437	7	9	10	97.8%	7.69	6.51	0.48	6.39	8.4	2
2014	October	0.207	0.325	1.57	0.169	296	708	511	28	40	39	92.3%	315	476	544	9	11	12	97.7%	6.72	6.43	0.20	7.09	9.5	27
2014	November	0.215	0.271	1.26	0.161	223	385	398	30	36	40	90.0%	371	541	665	12	16	16	97.5%	8.81	6.54	1.97	6.87	10.7	1
2014	December	0.210	0.390	1.86	0.169	215	314	376	23	34	32	91.5%	402	574	705	12	14	17	97.6%	7.92	7.18	18.14	6.19	11.1	1
2015	January	0.217	0.261	1.20	0.155	207	234	374	27	35	35	90.6%	305	373	552	15	16	19	96.5%	7.77	7.33	28.85	5.92	11.1	1
2015	February	0.210	0.324	1.55	0.163	101	202	177	38	46	52	70.5%	346	543	606	19	22	25	95.8%	7.96	7.53	32.10	6.59	12.1	1
2015	March	0.292	0.588	2.01	0.260	182	320	445	25	33	54	87.9%	901	1224	2200	21	24	46	97.9%	7.44	7.76	24.30	5.37	9.2	1
2015	April	0.229	0.472	2.07	0.199	272	423	520	27	61	44	91.5%	333	468	636	16	21	27	95.8%	7.35	6.57	21.96	5.81	9.3	2
2015	May	0.236	0.323	1.37	0.178	214	275	421	19	34	28	93.3%	280	319	551	11	13	17	97.0%	7.04	6.50	1.50	5.21	8.1	57
2015	June	0.214	0.284	1.33	0.183	756	2610	1352	21	27	31	97.7%	386	512	690	9	10	14	98.0%	7.06	6.58	0.45	7.24	7.2	479
2015	July	0.219	0.294	1.34	0.187	138	204	252	12	25	19	92.4%	266	357	486	11	15	17	96.4%	7.00	6.70	0.20	6.27	5.6	2
2015	August	0.224	0.266	1.19	0.182	173	304	323	10	15	16	95.2%	268	294	499	5	7	7	98.6%	7.20	6.80	0.20	5.62	4.7	403
2015	September	0.218	0.263	1.20	0.170	568	815	1034	9	16	13	98.7%	445	649	811	7	8	10	98.7%	7.00	6.80	0.25	5.70	5.6	3
2015	October	0.239	0.540	2.26	0.187	256	426	510	17	28	26	94.9%	873	1898	1742	7	10	11	99.4%	7.70	6.60	0.22	6.07	7.0	767
2015	November	0.248	0.552	2.23	0.209	367	513	759	40	88	70	90.7%	422	494	873	8	9	14	98.4%	7.10	7.00	0.20	6.00	8.4	21
2015	December	0.247	0.510	2.07	0.211	349	485	719	24	39	42	94.2%	385	663	793	10	14	18	97.7%	7.20	6.60	0.24	5.92	8.4	521
2016	January	0.217	0.255	1.18	0.160	149	170	269	71	187	94	65.0%	267	341	483	12	14	16	96.8%	7.40	6.70	5.18	6.32	12.1	1
2016	February	0.250	0.752	3.00	0.195	245	414	512	28	41	46	91.1%	998	1582	2084	23	30	37	98.2%	7.40	7.00	22.13	6.30	8.2	2
2016	March	0.241	0.627	2.60	0.198	382	495	769	48	108	79	89.8%	362	416	728	14	17	23	96.9%	7.70	6.80	20.04	6.66	8.3	1
2016	April	0.224	0.415	1.85	0.182	418	530	781	48	84	73	90.7%	344	411	643	12	15	18	97.2%	6.80	6.00	0.20	7.01	8.2	34
2016	May	0.215	0.311	1.44	0.184	600	1043	1078	31	44	48	95.5%	808	1102	1452	9	15	13	99.1%	7.50	6.50	0.20	6.09	7.4	2
2016	June	0.213	0.268	1.26	0.179	455	730	807	14	17	22	97.3%	389	879	690	10	16	15	97.8%	7.00	6.00	0.20	7.56	6.0	83
2016	July	0.227	0.455	2.00	0.191	196	328	372	24	63	38	89.7%	237	356	449	5	5	8	98.2%	7.20	6.50	0.20	6.97	6.1	1
2016	August	0.222	0.293	1.32	0.202	272	320	503	10	14	17	96.6%	272	315	504	6	7	10	98.0%	6.90	6.20	0.20	6.84	5.4	1
2016	September	0.218	0.273	1.25	0.162	278	684	506	7	8	9	98.1%	311	355	567	5	6	6	98.9%	7.10	6.40	0.32	5.56	5.4	4
2016	October	0.273	0.484	1.77	0.163	258	364	587	20	28	27	95.4%	326	443	744	6	7	8	98.9%	7.10	6.50	1.55	6.00	6.4	1
2016	November	0.288	0.489	1.70	0.162	307	380	738	29	50	39	94.7%	329	362	789	7	11	9	98.8%	7.20	6.40	3.80	5.61	7.7	521
2016	December	0.276	0.561	2.03	0.190	266	336	612	34	39	53	91.3%	225	322	519	13	15	21	96.0%	7.00	6.30	4.68	5.99	10.0	1
AVG (2014-2016)		0.232	0.385	1.64	0.183	371	851	716	32	51	49	90.4%	401	616	783	16	22	24	96.7%	7.44	6.69	10.87	6.31	8.0	84

Exhibit 4-2
Wastewater Flow Projections
Planning Period 2017-2037

Year	Existing Service Area					0-2 Year Expansion Area No. 1 (gpd)	3-10 Year Expansion Area No. 2 (gpd)	11-20 Year Expansion Area No. 3 (gpd)	Avg. Design Flow (gpd)	Peak Design Flow[D] (gpd)
	Population	% Change[A]	No. of Customers	Avg. Flow Per Customer[B] (gpd)	Avg. Wastewater Flow[C] (gpd)					
2017	2,830		1,387	166.5	230,987	-	-	-	230,987	378,965
2018	2,819	-0.38%	1,382	166.5	230,102	-	-	-	230,102	377,513
2019	2,809	-0.38%	1,377	166.5	229,217	-	-	-	229,217	376,060
2020	2,798	-0.39%	1,371	166.5	228,332	-	2,185	-	230,517	378,193
2021	2,785	-0.45%	1,365	166.5	227,302	-	4,370	-	231,672	380,088
2022	2,773	-0.45%	1,359	166.5	226,272	-	6,555	-	232,828	381,984
2023	2,760	-0.46%	1,353	166.5	225,242	-	8,741	-	233,983	383,879
2024	2,747	-0.46%	1,347	166.5	224,212	-	10,926	-	235,138	385,775
2025	2,735	-0.46%	1,341	166.5	223,183	-	13,111	-	236,294	387,670
2026	2,719	-0.57%	1,333	166.5	221,917	-	15,296	-	237,213	389,179
2027	2,704	-0.57%	1,325	166.5	220,652	-	17,481	-	238,133	390,688
2028	2,688	-0.57%	1,318	166.5	219,386	-	17,481	4,447	241,315	395,908
2029	2,673	-0.58%	1,310	166.5	218,120	-	17,481	8,895	244,496	401,128
2030	2,657	-0.58%	1,303	166.5	216,855	-	17,481	13,342	247,678	406,349
2031	2,639	-0.69%	1,293	166.5	215,348	-	17,481	17,790	250,619	411,173
2032	2,620	-0.70%	1,284	166.5	213,841	-	17,481	22,237	253,559	415,997
2033	2,602	-0.70%	1,275	166.5	212,334	-	17,481	26,684	256,500	420,821
2034	2,583	-0.71%	1,266	166.5	210,827	-	17,481	31,132	259,440	425,645
2035	2,565	-0.71%	1,257	166.5	209,320	-	17,481	35,579	262,381	430,470
2036	2,543	-0.85%	1,247	166.5	207,541	-	17,481	40,026	265,049	434,847
2037	2,521	-0.86%	1,236	166.5	205,761	-	17,481	44,474	267,717	439,224

Note
[A] It is assumed that growth of the City and the amount served by the City's wastewater facilities will grow at the same rate as the County.
[B] The Average Flow Per Customer in the existing service area is based on the historical data (Jan. 2014 through Dec. 2016), and includes all customer types (residential, commercial, industrial, etc.).
[C] Average WW Flow based on population growth in Existing Service Area.
[D] The Peaking Factor, 1.64, was derived by calculating the average of the average monthy peaking factors from histrorical data (Jan. 2014 through Dec. 2016).

Chapter 5
Existing Facilities

A. *General*

The City of Brandenburg's wastewater collection and treatment system was originally constructed in the early 1960's. The original wastewater treatment plant (WWTP) was built in 1963, rated for a maximum flow of 0.117 MGD, and upgraded in 1980. It consisted of grit removal, a comminutor, a primary clarifier, a rotating biological contactor (RBC) for biological treatment, a final clarifier, a chlorine contact basin, an aerobic digester, and sludge drying beds. Over time, the collection system has expanded outwards from the City's core and in the early 1990's the original WWTP was replaced. The new WWTP is discussed further in Part C of this Chapter.

The purpose of this chapter is to evaluate the capacity, capability and condition of the existing wastewater collection and treatment facilities.

B. *Collection System*

The Brandenburg wastewater collection system is considered "separate" as opposed to "combined", which means that there are separate pipes dedicated to transporting storm and sanitary flows. The collection system was originally constructed in the early 1960's and encompassed downtown Brandenburg, as well as some areas south of downtown. The original system mostly consisted of gravity sewer as it was able to follow the natural topography sloping towards the Ohio River from south to north. Since that time, the sewer system has expanded to accommodate the City's population growth. Gravity pipe remained the primary form of sewer, but several lift stations and force mains were required as the collection system continued to expand to the south, east, and west through undulating topography. The wastewater collection system within the Planning Area consists of the following components:

1. Wastewater Lift Stations

There are twenty-four (24) wastewater lift stations in Brandenburg. Two of the twenty-four lift stations are privately owned and operated. All lift stations are summarized in the following table and shown in Exhibit 5-1:

Table 5-1
Brandenburg Wastewater Lift Stations

Lift Station Name	Pump Type	Capacity (gpm)
Michael Lane	Submersible	***
B-Dury Elementary School	Submersible	80**
High Street	Submersible	60**
Brandenburg Bypass	Submersible	***
#2 Better Mobile Living	Submersible	120**
North Main	Submersible	1084
Worley Lane	Submersible	***
Bank Station	Submersible	200**
KFC/Taco Bell/Long John Silvers*	Submersible	***
Donna Drive	Submersible	180**
Riverport A	Submersible	***
Riverport B	Submersible	***

Table 5-1 Brandenburg Wastewater Lift Stations (Continued)		
Lift Station Name	**Pump Type**	**Capacity (gpm)**
River Bluff Beach Road	Submersible	***
Highway 933	Submersible	200**
Lisa Drive	Submersible	25**
Bypass Pumping Station	Submersible	***
School Side Drive	Submersible	***
Lusk Lane	Submersible	***
#3 Better Mobile Living	Submersible	120**
2 Pump Station 1692	Submersible	25**
Middle School	Submersible	200**
High School*	Submersible	***
HWY 170	Submersible	731**
Fair Grounds Road	Submersible	80**

*Privately owned and operated pump stations.
**Capacity provided by the Lincoln Trail ADD.
***Capacity unknown due to pumps being rebuilt and impellers modified.

The North Main Lift Station is the largest of the City's wastewater lift stations with four pumps ranging between 250 and 575 GPM. It is located off River Road in Brandenburg's Waterfront Park. The pump station was constructed in 1993 with the construction of the new WWTP.

In addition to the lift stations, there are approximately fifteen (15) private grinder pumps within the wastewater collection system. The applications for the grinder pumps include residential, commercial, industrial, institutional, and other.

2. Gravity Sewers

The wastewater collection system consists of approximately 130,500 linear feet of gravity sewer line. The following tables give a summary of the collection system broken down by pipe diameter and pipe material. A map of the system is presented in Exhibit 5-1. The gravity sewer sizes and lengths were provided by the Lincoln Trail ADD.

Table 5-2 Brandenburg Collection System Pipe Diameter Summary		
Pipe Diameter (in)	**Length (LF)**	**% of Total Length**
8	121,905	93.4%
10	8,572	6.6%
Total Length	**130,477**	**100%**

Table 5-3 Brandenburg Collection System Pipe Material Summary		
Pipe Material	**Length (LF)**	**% of Total Length**
PVC	79,144	60.7%
VCP	51,333	39.3%
Total Length	**130,477**	**100%**

3. Septic Systems

The Planning area currently has five residential areas that are serviced by septic systems:

Table 5-4
Residential Areas within Planning Area that are on Septic Systems

Residential Area	Approx. # of Septic Tanks
Four Oaks Road	22
Quail Run Road	56
Knollwood Road	27
River Edge Drive	21
Windsor Place	31
Sun Valley Road	30
Bud Wilson Road	37
Christian Church Road	25
Moremen Road	3

4. Collection System Condition

In general, the physical condition of the existing collection system, including gravity sewer lines and lift stations, allows the system to perform well during dry and wet weather.

The existing lift stations mentioned are all generally in good condition and are able to operate sufficiently. The North Main lift station is the largest lift station. It pumps the entire collection system - with the exception Riverport A and B - to the WWTP. The existing equipment, controls, and structural elements are generally in good condition. The lift station is located within the 100-year flood plain. The controls for the pumps are located at the retired WWTP, which is above the 100-year flood plain. The City would like to move the controls out for the retired WWTP to make the controls more accessible.

The Middle School lift station is a duplex lift station with submersible pumps, wet wells, controls, and valve vaults. The valve vault was replaced in 2009. The hatch over the wet well and control panels needs to be replaced. The City would potentially like to increase the capacity of the lift station. A hydraulic model wasn't complete for this Facilities Plan. A model would need to be completed to assess the capacity of the existing lift station and make recommendations to increase the capacity.

Many of the gravity sewers in the collection system are aged and approaching 50-60 years in service (specifically downtown). Also, roughly forty percent (40%) were constructed of vitrified clay pipe. Based on the calculations completed in Chapter 4, the City isn't required to complete a sanitary sewer study. However, based on the age and material of the majority of the collection system, it would be recommended that the City establish a CCTV program to review the existing collection system. As previously mentioned, a hydraulic model wasn't completed for the collection system. A hydraulic model would help establish capacity issues that exist with the system. In addition to CCTV identifying the areas that would potentially need to be replaced or rehabilitated, the model would be useful in establishing which sewers require upsizing.

Inflow and infiltration into the collection system was previously discussed in section F of Chapter 4. The City doesn't currently have any known sanitary sewer overflow locations.

C. Brandenburg Wastewater Treatment Plant

1. General

The existing Brandenburg WWTP is located on Buttermilk Falls Road east of downtown Brandenburg. The plant outfall is located near National Hydrography Dataset (NHD) mile point 643.3 of the Ohio River, segment 08217.

The treatment plant was originally constructed in 1993. It has a rated capacity of 0.312 MGD average daily flow (ADF) and 0.932 MGD peak flow. The Brandenburg WWTP replaced the existing treatment facility located on River Road. The "old" treatment plant was originally constructed in 1963 with a capacity of 0.19 MGD. It remained in operation until the completion of the existing treatment plant, and was retired once it reached the end of its design life in 1993. Currently all wastewater flow is pumped and treated at the "new" WWTP.

The existing facility consists of the North Main influent lift station, influent flow metering via magnetic flow meter (a.k.a "mag meter"), a mechanical inline grinder and bypass screen, two

(2) facultative lagoons, two (2) secondary clarifiers, disinfection using chlorine gas, de-chlorination using sulfur dioxide, effluent flow measurement via Parshall Flume, and a return activated sludge (RAS) pump station. A schematic diagram of the existing plant is shown in Exhibit 5-2.

A copy of the current KPDES Permit is located in Appendix D.

2. Plant Capacity

According to the 1993 Operation and Maintenance Manual, the Brandenburg WWTP has the following design capacity:

Table 5-5 Brandenburg WWTP Current Design Capacity	
Design Population	3,496
Influent BOD_5 Loading	870 lbs/day
Influent TSS Loading	840 lbs/day
Influent Ammonia-Nitrogen Loading	70 lbs/day
Average Daily Flow (ADF)	0.312 MGD
Peak Hydraulic Flow (PHF)	0.932 MGD

As can be seen in Exhibit 4-1, the influent loadings have averaged 783 lbs BOD_5/day and 716 lbs TSS/day, respectively, over the past three years (January 2014 through December 2016). The averages for both influent BOD_5 and TSS loading were below the design capacity. However, there were eight months over the past three years where the average monthly influent TSS loading exceed the design capacity. The average monthly influent BOD_5 loading had six months exceeding the design capacity. This has stressed the plant and resulted in periodic discharge limit violations as well as an Agreed Order (see discussion in Chapter 5, Section F, Part 2).

3. On-Site Storm Water Management

The Brandenburg WWTP is outside the 100-year floodplain of both the Ohio River and Flippins Run. Additionally, the majority of WWTP site is grass and the treatment processes are open to the atmosphere. Based on the site layout, the on-site storm water management is minimum. There is one culvert located beneath the access drive and a drainage ditch along the access drive to the south of site. The access drainage ditch ties into a drainage ditch along the south side of the plant site and drains to the west towards Flippins Run.

4. Influent Lift Stations

Raw wastewater can enter the Brandenburg WWTP from three existing lift stations: North Main, Riverport A, and Riverport B.

The North Main Lift Station is the primary location where raw wastewater from the Brandenburg Collection System is pumped to the WWTP. The North Main Lift Station is comprised of two duplex lift stations. An upstream manhole diverts the flow to either duplex lift station, which tie into the same discharge header and then to the head of the WWTP. The north duplex lift station was originally designed with one submersible pump capable of pumping 731 GPM at 78 feet of total dynamic head (TDH), and a second submersible pump capable of pumping 400 GPM at 60 feet TDH. The south duplex lift station was originally designed with one submersible pump capable of pumping 400 GPM at 58 feet of total dynamic head (TDH), and a second submersible pump capable of pumping 100 GPM at 58 feet TDH.

The four pumps within the North Main Lift Station have been modified since the station's original construction, altering the flow rate of each pump. The 731 and 400 GPM pumps within the north duplex lift station now have flow rates of 575 and 429 GPM, respectively. The 400 and 100 GPM pumps within the south duplex lift station now have flow rates of 509 and 250 GPM, respectively.

The raw wastewater is pumped through a 10-inch PVC force main, approximately 5,110 feet to the WWTP that lies to the east. The lift station and force main were both built with the existing Brandenburg WWTP circa 1993.

Based on the 1993 O&M manual, for normal operation for water level rising, the initial pump control settings are as follows:

Table 5-6 North Main Lift Station Initial Control Settings Water Level Rising		
Elevation	**Wet Well Depth (ft)**	**Action**
412.75	5.75	Pump No. 4 Starts
413.19	6.19	Pump No. 2 Starts Pump No.4 Stops
413.69	6.69	Pump No. 3 Starts
414.36	7.36	Pump No. 2 and 3 Stop Pump No. 1 and 4 Start
419.25	12.25	All Pumps Stop

Pump No. 1: 575 GPM
Pump No. 2: 429 GPM
Pump No. 3: 509 GPM
Pump No. 4: 250 GPM

Based on the 1993 O&M manual, for normal operation for water level falling, the initial pump control settings are as follows:

Table 5-7 North Main Lift Station Initial Control Settings Water Level Falling		
Elevation	**Wet Well Depth (ft)**	**Action**
418.25	11.25	All pumps reset
410.25	3.25	Pump No. 1,2, and 3 Stop
410.00	3.00	Pump No. 4 Stops

Pump No. 1: 575 GPM
Pump No. 2: 429 GPM
Pump No. 3: 509 GPM
Pump No. 4: 250 GPM

The Riverport A and B Lift Stations were built to serve industry development northeast of the WWTP along the Ohio River. Each station pumps raw wastewater through separate 6-inch PVC force mains, approximately 1,485 (Riverport A) and 940 (Riverport B) feet to the WWTP. The Riverport A Lift Station currently only pumps raw wastewater from the Consolidated Grain and Barge Company. The Riverport B Pump Station does not currently receive raw wastewater from an industry, but a welding company will be providing domestic flows in the near future. The two force mains tie together prior to the flow meter. The combined force main then ties into the south wall of the pretreatment channel.

The North Main Lift Station has sufficient pumping capacity to adequately transport the projected 2037 average daily flow of 0.268 MGD and the projected 2037 peak hydraulic flow of 0.439 MGD. It is assumed that the majority of projected flow will be conveyed through the North Main Lift Station. A small percentage of the projected flows will continue to be conveyed through Riverport A and B Lift Stations, which both have available pumping capacity. Performing a hydraulic model in the future would be recommended to determine, if the project 2037 average daily flow would require modifications to the North Main Lift Station.

5. Raw Wastewater Flow Measurement

The raw wastewater flow is measured at two locations. The North Main Lift Station influent is measured in a manhole west of the screening chamber. The Riverport A and B Lift Station influents are measured in a manhole south of the screening chamber. Each manhole contains a mag meter to measure the flows through the force mains. The North Main Lift Station manhole appears in satisfactory condition and the mag meter was replaced in 2010. The River Port Lift Station manhole appears in satisfactory condition and the mag meter was replaced in 2010. Both meters appear to be in satisfactory condition.

6. Pretreatment

a. Mechanical Inline Grinder/ Screen/ Compactor

The plant originally contained a mechanically-cleaned bar screen capable of handling a peak flow of 1.011 MGD. The screen was designed to remove large solids and stringy material from the influent, and consisted of a bar rack with ½-inch openings between bars and cleaning rakes. The mechanically-cleaned bar screen was replaced in 2010 with a mechanical inline grinder/ screen/ compactor. The mechanical inline grinder/ screen/ compactor is a rotating auger with peak flow capacity of 1.1 MGD. The rotating auger has a spiral lifting screw with perforated screens. The spiral lifting screw removes solids to a garbage bin while soft organics are washed back into the channel through the perforated screens. The mechanical inline grinder/ screen/ compactor is performing adequately, but the City has had issues with the influent sensor causing the screen to run on a timer. The City is working to resolve this problem.

b. Manually-Cleaned Screen

The manually-cleaned bar screen serves as an emergency bypass. The manual bar screen is located in a parallel channel with the inline mechanical inline grinder/ screen/ compactor in the screening chamber. An opening in the concrete wall splitting the two channels has a stainless steel overflow weir plate. When the influent flow exceeds the capacity of the mechanical bar screen channel, the flow crests over the weir plate and enters the manually-cleaned bar screen channel. The manual screen consists of aluminum bars spaced 1-inch apart and is cleaned by hand. Since the bar racks are manually cleaned, the screen cleaning process is cumbersome and labor intensive. The manual bar screen has been in service for approximately 25 years, but appears to be in good condition.

c. Screening Chamber

The screening chamber has a design capacity of 0.312 MGD average daily and 0.932 MGD peak hydraulic flow. The City reports, however, that when a combination of influent pumps turn on it creates a burping affect. This occasionally results in the influent flow overtopping the weir and flowing through the manual bar screen. The frequency of the flow overtopping the weir plate has led to solids reaching the lagoons that would normally be removed by the mechanical inline grinder/ screen/ compactor. Raising the height of the weir plant will be investigated to reduce the number of overflows.

The screening chamber has a 24” x 34” channel gate within the mechanical inline grinder/ screen/ compactor channel, which allows for maintenance. The screening chamber and channel gate have been in service for approximately 25 years. The concrete of the screening chamber has started to show wear, and some of the aluminum grating over portions of the channel have been removed.

7. Screen Effluent - Box No. 1

Raw wastewater flows from the screening chamber into Screen Effluent Box No. 1, which distributes flow to the two (2) existing lagoon cells and receives return activated sludge (RAS) from the scum/sludge/dewatering pump station. The box contains a concrete wall splitting the box into two cells, one for each existing lagoon, as well as a stop gate. The stop gate controls flow by blocking all flow to one of cells. During normal operation, the stop gate will be installed to block all flow to Box No. 2 just upstream of Lagoon Cell No. 2. If Lagoon Cell No. 1 requires maintenance, the stop gate will be installed to block all flow to Lagoon Cell No. 1 and diverted to Box No. 2. Box No. 1 has been in service approximately 25 years. The portion of concrete box that brings flow to Lagoon No. 1 has begun to show wear due to the influent raw wastewater, and needs to be repaired. Other portions of the concrete structure appear to be in satisfactory condition. The stop gates and gate guides appear to be in satisfactory condition, as well.

8. Facultative Lagoons

The Brandenburg WWTP has two (2) existing facultative lagoons for the purpose of biological treatment. The facultative lagoons utilize both aerobic and anaerobic treatment processes for organic removal. During normal operation, raw wastewater enters Lagoon Cell No. 1, where it is partially aerated by four floating aerators operating on timers. The treated wastewater is discharged to Box No. 2. Within Box No. 2, the flow will be diverted to Lagoon Cell No. 2. The wastewater will undergo the same treatment process as Lagoon Cell No. 1. The Lagoon Cell No. 2 effluent discharges to the Chlorination Induction Station. When maintenance is required, Lagoon Cell No. 1 or 2 can be bypassed using the stop gates within Box Nos. 1 and 2.

Each facultative lagoon cell is approximately 246’-0” x 246’-0” with a normal depth of 17’-6”. The total volume of the two lagoons is approximately eight million gallons. The hydraulic retention time within each cell is 10 days. The lagoons are divided into three zones: aerobic, quiescent, and anaerobic. The aerobic zone is the upper zone. The approximate volume of this zone is 3.16 million gallons per cell and makes up the top 11.5 feet of each. This zone supports aerobic bacteria converting wastes to carbon dioxide, ammonia, and phosphates. The middle zone is the quiescent zone. The approximate volume of this zone is 0.49 million gallons per cell and three feet deep. This zone allows solids to settle. The anaerobic zone is at the bottom of each cell. The approximate volume of this zone is 0.374 million gallons per cell, and consists if the bottom three feet of the lagoons. The settled solids from the quiescent zone are decomposed within this zone.

The lagoon lining is from the original plant construction in 1993 and is showing signs of wear and tear. There are a number of spot repairs, as well as signs of settlement on the slopes of the lagoons. Also, Lagoon Cell No. 1 often times contains numerous large solids (i.e. wrappers) that would have normally been captured by the mechanical inline grinder/ screen/ compactor. Instead, these solids have been able to pass through the manual bar screen during periods when the mechanical inline grinder/ screen/ compactor has been down for repairs. During down times, the flow is diverted through the manual bar screen.

Routine maintenance is required on this type of treatment process to control the sludge build-up on the bottom of the lagoons. Sludge build-up can lead to higher TSS, BOD_5, and ammonia effluent levels. According to the 1993 O&M Manual, the facultative lagoons have a 20-year design period. The existing lagoons have been in operation for 20+ years and have not been dredged during that time. As previously mentioned, the WWTP has experienced months where the influent BOD_5 and TSS loadings exceed the design capacity of the WWTP. This has contributed to the sludge accumulating within the lagoons more quickly than originally designed. Dredging the two lagoons can help reduce the high effluent TSS, BOD_5, and ammonia levels that have resulted in permit violations. In the future, it is recommended they City perform regular sludge accumulation mapping (see Appendix M for survey performed on May 3, 2017) to help manage build-up. Maintaining the appropriate sludge blanket is vital to a lagoon's performance.

Each cell has four (4) 15 HP floating aerators that provide mixing and oxygen to activated sludge in the upper portions of the lagoons. The aerators operate on 24-hour timers to control the dissolved oxygen concentration within the aerobic zone. The timers are manually adjusted by the operator based DO readings during their weekly samples. The original eight (8) floating aerators have recently been replace with new floating aerators. The eight aerators were replaced between June 2014 and June 2016.

9. Lagoon Cell No. 1 Effluent – Box No. 2

Lagoon Cell No. 1 Effluent – Box No. 2 is located in between Lagoon Cell No. 1 and 2. Box No. 2 can distribute the wastewater flow in a number of directions depending on how the plant is currently being operated. The box has four slots for stop gates to direct the flow as the plant operator desires. During normal operation, effluent from Lagoon Cell No. 1 will be directed to Lagoon Cell No. 2. Three stop gates will be arranged in Box No. 2 to prevent flow from going to the Chlorine Induction Station, as well as to prevent any flow coming in from Box No. 1.

If Lagoon Cell No. 1 is offline, effluent from Box No. 1 will be diverted to Lagoon Cell No. 2. In that scenario, stop gates will be arranged in Box No. 1 and 2 to prevent flow from going to both the Chlorine Induction Station and Lagoon Cell No. 1. If Lagoon Cell No. 2 is offline, effluent from Lagoon Cell No. 1 will be directed to the Chlorine Induction Station. The three stop gates will be arranged in Box No. 2 to prevent flow going to Lagoon Cell No. 2, as well as to prevent any flow coming in Box No. 1. Box No. 2 was constructed in 1993 and the concrete and slide gates appear to be in satisfactory condition.

10. Chorine Disinfection Facilities

Disinfection at the Brandenburg WWTP is currently accomplished using chlorine. Disinfection of plant effluent is accomplished with the chlorine being introduced to the waste stream via an induction unit at the Chlorination Induction Station.

The chlorination/disinfection facilities at the Brandenburg WWTP include chlorine storage, chlorinators, and the Chlorination Induction Station. The chlorination equipment is primarily located in the Chlorine Enclosure. The equipment and facilities appear to be in marginal condition with signs of corrosion.

a. Chlorine Storage Facility

The chlorine feed system is designed to supply gaseous chlorine from two 150 pound chlorine cylinders to the chlorinators. The cylinders are housed in the Chlorine Enclosure east of the Dechlorination Induction Station.

There are individual scales for the two 150 pound cylinders which provide continuous and direct measurement of the remaining chlorine within a cylinder. The cylinders are paired together on the scale. Automatic switchovers are in service.

The Chlorine Enclosure is equipped with all required safety equipment such as leak detection equipment and exhaust fans. A warning light and alarm is located on the enclosure, and a secondary warning light is located in the control building. A freeze-proof emergency eyewash and shower is located next to the Chlorine Enclosure. The air supply tanks with gas masks are located in the control building. There is not a scrubber in the existing facility.

The Chlorine Enclosure was built with the original plant construction in 1993. The enclosure has begun to deteriorate and will likely be demolished if the City decides to convert to an alternative form of disinfection.

b. Chlorinators

One 200 pound per day vacuum solution feed chlorinators supplies chorine for chlorination. The chlorinator feed rates are controlled by one 0 to 30 pound per day rotameter. A spare chlorinator is provided as a standby and has a 50 pound per day rotameter. A feed line supplies chlorine solution to the Chlorination Induction Station.

The chlorinator will feed chlorine through the induction unit and automatically adjust its feed rate according to the amount of wastewater flow. The flow metering equipment at the Parshall Flume will send a signal to the chlorinator and adjust the chlorine. The chlorinators will likely be removed if the City decides to convert to an alternative form of disinfection.

c. Chlorination Induction Station

The Chlorination Induction Station is a 6'-0" diameter by 12'-9" deep concrete structure. The effluent from Lagoon Cell No. 1 and/or 2 is gravity fed to the Chlorination Induction Station. The wastewater enters the station and flows beneath a stainless steel baffle. An induction unit supplies the chlorine solution to the wastewater. The mixed chlorine solution and wastewater passes through to the clarifiers. The clarifiers provide the necessary chlorine contact time. On February 1, 2017, via telephone, the KDOW said that a Contact Tank would be required with either the existing chlorine or potential peracetic acid (PAA) feed system. The Chlorination Induction Station was part of the original plant construction in 1993, and the concrete structure appears to be in satisfactory condition. The induction unit was recently replaced in 2014. The current induction unit doesn't appear to provide adequate mixing. In the event that an alternative disinfectant is used, the manholes will likely just become a "pass through" from the lagoons to the clarifiers, or simply be abandoned.

11. Clarifier/Contact Basin Influent – Box No. 3

Effluent from the Chlorination Induction Station flows through Clarifier/Contact Basin Influent – Box No. 3 to the two (2) secondary clarifiers. Box No. 3 contains a concrete wall splitting the structure into two cells, one for each existing clarifier, as well as a spot for a stop gate. The stop gate controls flow by blocking all flow to one of clarifiers. During normal operation no stop gate is installed, allowing effluent to be evenly distributed to both clarifiers. If either clarifier needs to be bypassed for maintenance, the stop gate will be installed and all effluent to that clarifier will be blocked. Box No. 3

was constructed in 1993 and the concrete and slide gates appear to be in satisfactory condition.

12. Clarifiers/Contact Basins

The effluent from Box No. 3 is gravity fed to the east and west clarifiers. The two secondary center-feed clarifiers are 36-foot diameter and have a 12-foot side water depth. Each have two scraper arms and one skimmer arm. The clarifiers allow the solids to flocculate and settle out, as well as provide contact time for chlorination. The settled effluent flows out of the clarifier's v-notch weirs and weir troughs to Box No. 4. The skimmer arm rotates on the surface of the clarifiers to remove scum from the surface to the scum box. The two scraper arms rotate on the bottom of the clarifiers to push sludge to the center of the structure. The scum and sludge both flow to the decant manhole.

The two clarifiers were constructed with the original WWTP construction in 1993. The concrete appears to be in satisfactory condition for both. The west clarifier has the original drive unit. The east clarifier's drive unit was replaced in 2014. The railing, grating, and drive units on both clarifiers need to be blasted and coated if kept in service. Water leaks around the v-notch weirs in both clarifiers, which should be repaired or replaced if kept in service. The skimmers need to be replaced in both structures if kept in service, as well.

As previously mentioned, KDOW will require the City to stop using the clarifiers as contact basins and construct a separate contact tank. The clarifiers were originally used as contact basins where the chlorine could help lower TSS by allowing filamentous bacteria to settle within the basins. The issue with the clarifiers being used as contact basins, however, is that the "bugs" that assist with the biological process are often times killed in the clarifiers, settle, and then are returned to the lagoons. The dead "bugs" cause more sludge build-up then originally designed, resulting in a reduced lagoon storage capacity. In turn, more filamentous bacteria is within the lagoons, and the clarifiers require more chlorine to help settle it. Also, the sludge build-up reduces detention time in lagoons, not allowing solids to properly settle out. Adding chlorine prior to the clarifiers has likely contributed to some of the WWTP's TSS violations.

The existing clarifiers have a total surface area of 2,036 ft^2. This results in an average overflow rate of 154 gpd/ft^2 at the current average design flow of 0.312 MGD, and a peak overflow rate of 458 gpd/ft^2 at the current peak hydraulic flow of 0.932 MGD. This is below the Ten States Standards design criteria of 1,000 gpd/ft^2 under peak conditions.

13. Decant Manhole

The scum and sludge from the east and west clarifiers flow through the decant manhole to the Scum/Sludge/Dewater Pump Station. The scum from the east and west clarifiers tee together between the two structures and gravity feed into the decant manhole through a 6-inch pipe. The sludge effluent from each clarifier flows into the decant manhole from two separate 8-inch gravity pipes. The sludge flow from the clarifiers is controlled by two telescoping valves located in the decant manhole.

The decant manhole was constructed with the original WWTP in 1993. One gate valve has been replaced and a second replacement gate valve has been purchased, but not installed. The concrete and telescoping valves appears to be in satisfactory condition, but the operator on the telescoping valves could be blasted and painted if kept in service.

14. Scum/Sludge/Dewater Pump Station

The scum and sludge mixture (return activated sludge) enters the Scum/Sludge/Dewater Pump Station concrete wet well through an 8-inch gravity sewer fed by the decant manhole. The return activated sludge (RAS) is pumped through the valve vault to Box No. 1, and then into the lagoon cells, initiating the secondary biological treatment process.

The pump station is made up of two separate concrete structures: wet well and valve vault. The wet well is 8-foot diameter, 26.5-foot deep concrete structure with two submersible pumps, each with a rated capacity of 180 GPM (0.26 MGD). Each pump has a 3 horsepower motor and discharges through a 6-inch force main to the valve vault. The vault valve is 6-foot diameter, 4.5-foot deep with two check and gate valves. The two pump discharge force mains tie together with a wye within the valve vault. The single force main then pumps to Box No. 1.

Ten States Standards recommends that RAS pumping capacity be provided to pump between 50% and 150% of the average design flow (ADF). Based on the design pumping conditions, the existing pumps produce 180 gpm (0.26 MGD) with one pump running, which is 112% of the ADF. With both pumps running, the RAS pumping capacity is 360 gpm (0.52 MGD), which is 223% of the ADF. Therefore, the existing RAS facility still has the capacity to meet the recommended Ten States Standards criteria at the current design flow. For the projected future flows, the percentage of ADF with one and two pumps running are 97% and 194%, respectively. The existing pumps would meet the recommended Ten State Standard.

The Scum/Sludge/Dewater Pump Station was constructed in 1993 and the concrete structure still appears to be in generally good condition. The pumps and valves all appear in good condition, as well. The pump control panel has come hydrogen sulfide damage. A new control panel and sealing of the conduit are recommended if kept in service.

Based on the 1993 O&M manual, the pump station control settings for normal operation are as follows:

Table 5-7
Scum/Sludge/Dewater Pump Station Control Settings

Elevation	Wet Well Depth (ft)	Lead	Lag
446.00*	6	ON	ON
445.50	5.5	ON	ON
445.00	5	ON	OFF
443.00	3	OFF	OFF

* High level alarm

According to the City Staff, however, the pumps run full-time.

15. Clarifier/Contact Basin Effluent – Box No. 4

Effluent from the east and west Clarifiers flows through Final Clarifier/Contact Basin Effluent – Box No. 4 to the Dechlorination Induction Station. Box No. 4 contains a concrete wall splitting the box into two cells, one for each existing clarifier, and a stop gate. The stop gate controls flow by blocking all flow from one of the clarifiers. During normal operation, no stop gate is installed allowing effluent from both clarifiers to the Dechlorination Induction Station. If flow from either clarifier needs to be stopped, the gate will be installed and all effluent from that clarifier will be blocked. Box No. 4 was constructed in 1993 and the concrete and slide gates appear to be in satisfactory condition.

16. Dechlorination Facilities

The Brandenburg WWTP KPDES permit limits the chlorine concentration in the final effluent water. As a result, Sulfur dioxide is utilized as a de-chlorination agent to remove chlorine from the effluent. Sulfur dioxide feed equipment is located in the Dechlorination Enclosure. The equipment is in marginal condition with signs of corrosion. The sulfur dioxide is fed as a solution through an induction unit located at the Dechlorination Induction Station.

a. Sulfur Dioxide Storage Facility

The sulfur dioxide feed system is designed to supply gaseous sulfur dioxide from two 150 pound sulfur dioxide cylinders to the sulfonators. The cylinders are housed in the Sulfur Dioxide Enclosure east of the Dechlorination Induction Station.

There are individual scales for two 150 pound cylinders which provide continuous and direct measurement of the remaining sulfur dioxide within a cylinder. The cylinders are paired together on the scale. Automatic switchovers are in service.

The Sulfur Dioxide Enclosure is equipped with all required safety equipment such as leak detection equipment and exhaust fans. A warning light and alarm is located on the enclosure and a secondary warning light is located in the control building. A freeze-proof emergency eyewash and shower is located next to the Sulfur Dioxide Enclosure. The air supply tanks with gas masks are located in the control building. There is not a scrubber in the existing facility.

The Dechlorination Enclosure was built with the original plant construction in 1993. The enclosure has begun to deteriorate and will likely be demolished if the City decides to convert to an alternative disinfectant.

b. Sulfonator

One 200 pound per day vacuum solution feed sulfonator supply sulfur dioxide for dechlorination. The sulfonator feed rates are controlled by one 20 pound per day rotameter. A spare sulfonator is provided as a standby and has a 50 pound per day rotameter. A feed line supplies sulfur dioxide solution to the Dechlorination Induction Station.

The sulfonator will feed sulfur dioxide through the induction unit and automatically adjust its feed rate according to the amount of wastewater flow. The flow metering equipment at the parshall flume will send a signal to the sulfonator and adjust the sulfur dioxide. The sulfonator will likely be removed if the City decides to convert to an alternative disinfectant.

c. Dechlorination Induction Station

The Dechlorination Induction Station is a 6’-0” diameter and 15’-6” deep concrete structure that is gravity fed by Box No. 4. The wastewater enters the station and flows beneath a stainless steel baffle. An induction unit supplies the sulfur dioxide solution to the wastewater. The induction unit has been replaced numerous times in the past 15 years. The mixed sulfur dioxide solution and wastewater passes through to a manhole prior to entering the parshall flume. The reaction between the sulfur dioxide and chlorine is instantaneous. No additional detention time is required after the Dechlorination Induction Station. The Dechlorination Induction Station was part of the original plant construction in 1993. The concrete structure appears to be in satisfactory condition.

17. Plant Effluent Flow Measurement

The discharge from the Dechlorination Induction Station passes through a Parshall Flume prior to flowing to the outfall. The Parshall Flume has a 6-inch throat width and is used to measure the plant effluent flow rate. The flume was installed during the original plant construction in 1993. The concrete structure containing the Parshall Flume appears to be in satisfactory condition. The transponder and parshall flume were both replaced in 2017. Aluminum grating is also missing over portions of the channel and need to be replaced.

18. Outfall

The treated wastewater from the Brandenburg WWTP flows through a 15-inch gravity sewer approximately 2,200 LF to its outfall on the Ohio River. The outfall is a concrete headwall with flow dispersal pier and rip rap. The flow dispersal pier acts as an energy dissipator and the rip rap reduces erosion from the effluent flow. The outfall was installed during the original plant construction in 1993. The headwall is in satisfactory condition, but the flow dispersal pier is missing and needs to be replaced. The rip rap has begun to deteriorate and is collecting debris. The debris will need to be remove and additional rip rap added.

19. Automatic Samplers

The plant has two (2) stationary refrigerated automatics samplers, each located where the process flow is to be sampled.

The stationary automatic samplers are installed at the following locations:

a. Screening Chamber (Plant Influent)

b. Parshall Flume (Plant Effluent)

The influent and effluent automatic samplers were replaced in 2011 and 2013, respectively, and both appear to be in satisfactory condition.

20. Control Building and Plant Site

The Brandenburg WWTP Control Building was constructed along with the original plant. It has an office, a laboratory, mechanical room, lavatory, and garage. Additionally, just northwest of the Control Building, is a small sump pump station that pumps any wastewater from the Control Building. The force main pumps into the south wall of the screening channel just below the Riverport force main. The roof on the Control Building has been replaced within the past 10 years, but some of the interior ceilings tiles appear to have water damage and should be replaced. The plant control panel no longer works and the laboratory isn't used since all plant sampling is now performed by others. The building also requires new exterior lights. The sump pump station appears to be in satisfactory condition and the pumps were recently replaced in 2012.

The WWTP was originally accessed on the south side from Buttermilk Farms Road. Buttermilk Farms Road has recently been converted to a pedestrian path. As a result, the City has installed a new access gate on the north side of the WWTP site, as well as a temporary gravel road from the north gate to the existing drive. The existing drive and temporary drive will be paved as part of the selected treatment alternative construction. New site lighting will be installed with the constriction of the selected treatment alternative, as well.

21. Biosolids Processing and Disposal

Biosolids (sludge) are created in the plants two (2) lagoons and two (2) final clarifiers. The solids from raw wastewater settle to the bottom of the lagoons creating a sludge layer. Biosolids that don't settle within the lagoons will settle to the bottom of the clarifiers, while clear effluent flows from the surface into the clarifier effluent channel and onto dechlorination. The sludge from the bottom of the clarifiers is returned as RAS (Return Activated Sludge) to Box No. 1 for use as biological treatment. The plant doesn't waste any sludge. The lagoons of Brandenburg's WWTP are designed to store sludge for a 20 year design period. It has been approximately 25 years since the lagoons have been in operation and they have not been cleaned. It is recommended that the lagoons are cleaned and biosolids are disposed of at a permitted landfill or landfarm.

D. Operation & Maintenance Procedures

1. Staff

The City of Brandenburg currently has a total staff of four to operate and maintain the wastewater plant and collection system. Two staff members are certified WWTP operators with one of those staff members also being certified for the collection system. A table presenting the operators, their classifications, and their certification numbers is shown below:

Table 5-9
Brandenburg WWTP and Collection System Staff

Name	Cert. No.	Cert. Level
T.J. Hughes*	01520	II
T.J. Hughes**	19382	II
Gary Hardesty*	16469	II

* WWTP Operator
** Collection System Operator

2. Procedures

The Brandenburg staff visit the WWTP daily. The staff will perform a walkthrough of all the WWTP's processes and take note of anything not performing correctly. Anything not performing will be addressed onsite and repaired. The WWTP will then be "washed down." This process requires the staff to hose down the clarifiers to remove any algae buildup within the troughs. The pump hours for all pumps are recorded. This process typically takes approximately 2-3 hours in the morning.

E. Bypasses and Overflows

Bypasses occur when there is excessive flow and a wastewater treatment plant or combined sewer cannot take the hydraulic load. In some collection systems combined sewer overflows (CSOs) were constructed intentionally for the purpose of discharging untreated excess flow into a receiving stream. An overflow, also known as a Sanitary Sewer Overflow (SSO), occurs when wastewater flow exceeds the capacity of the collection system pipes and/or pump stations. The wastewater then backs up through manholes or other points in the system open to the atmosphere. Both bypasses and overflows generally occur during wet weather, when storm water finds its way into the wastewater collection system by inflow and/or infiltration.

The City of Brandenburg has no combined sewers, and therefore has no CSOs. There are currently no documented SSOs within the Brandenburg Collection System.

F. <u>Need for the Project</u>

1. Compliance Status

The Brandenburg WWTP has at times failed to comply with existing KPDES permit limits for BOD_5, TSS, SS% removal, NH_3N, E. Coli. and pH, though the plant generally meets effluent limits (a copy of the KPDES permit is located in Appendix D). As a result of the KDPES permit violations, the City entered into an Agreed Order with KDOW.

2. Agreed Order

The City of Brandenburg entered into an Agreed Order (AO Case No. DOW 150453) with the Commonwealth of Kentucky Energy and Environment Cabinet Division of Enforcement (DENF) in June of 2016. The Agreed Order cited several Notices of Violation that occurred between May 2011 and December 2015, and required the City to implement various remedial measures.

The required remedial measures included: immediate reporting of all spills, bypass discharges, upset condition discharges, and releases of substances which would result in the pollution of the waters of the Commonwealth; proper and regular operation and maintenance of the sewage collection system and WWTP; submit to DENF for review and acceptance, a written Corrective Action Plan (CAP) to bring the facility into compliance with its KPDES permit; and cease all discharges that are degrading the waters of the Commonwealth. The CAP recommended updating the City's Wastewater Facilities Plan and upgrading the WWTP according to the Facilities Plan recommendations.

The CAP also outlined measures taken over the period of time from June 2014 and June 2016 to try to remain in compliance with their KPDES permit. Those included: replacing all 8 aerators, replacing chlorine and sulfur dioxide pumps, new clarifier drive and torque control, and various electrical work.

3. Surface Water Quality

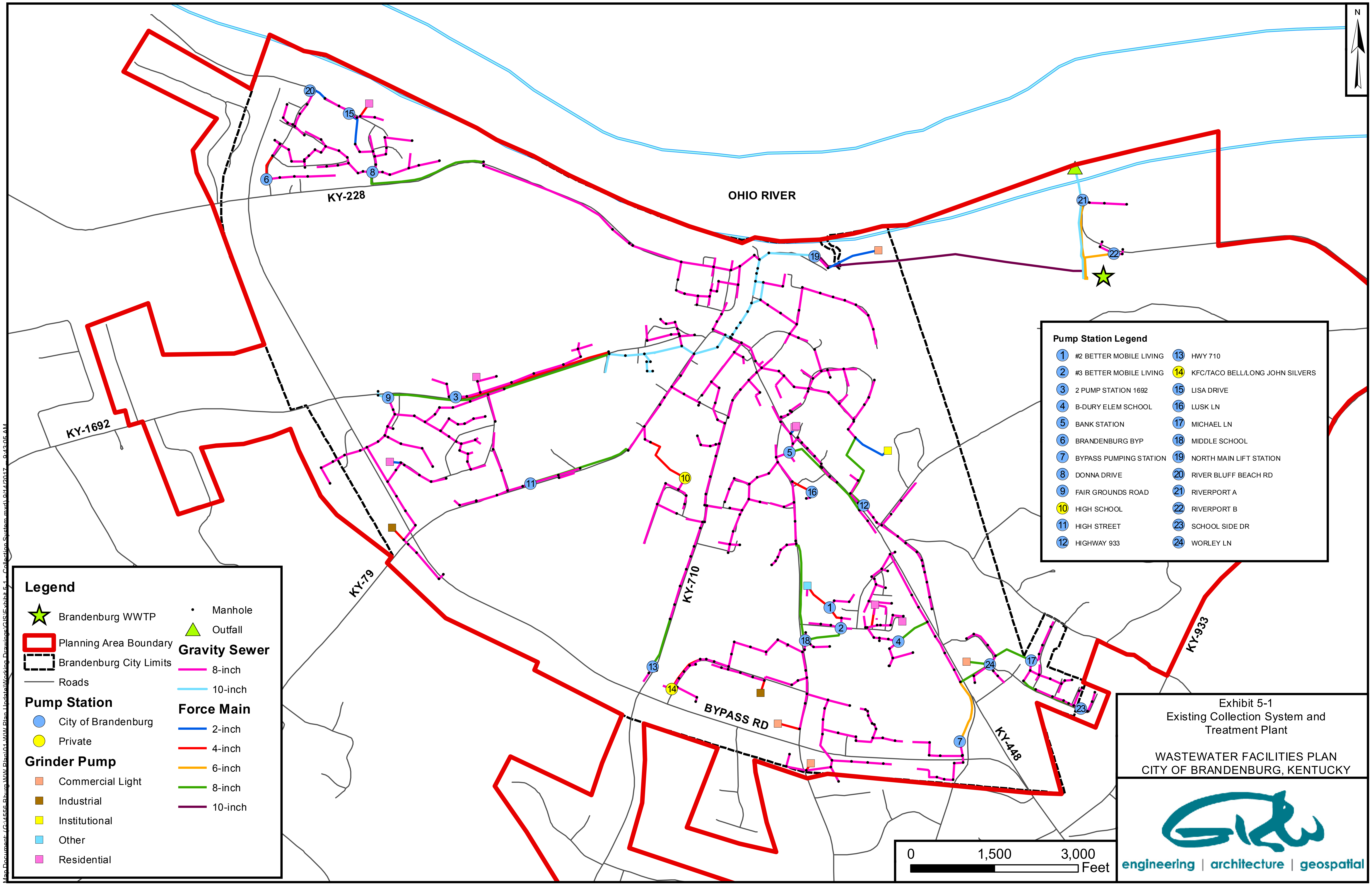
Several stream segments in Meade County (including the Ohio River which is the receiving stream for the WWTP effluent) are listed on the 305(b) Report as impaired, and are found to not support, or only partially support, one or more of their intended uses. See Chapter 2, Section I, Part 5 for a more in-depth discussion of surface water quality.

4. Future Environment without the Proposed Project

A "No-Action" scenario will eventually lead to a negative environmental impact. The plant currently receives permit violations. The violations will continue and potentially increase as the WWTP gets older within any upgrades or modifications.

5. Septic Tanks

There are several existing neighborhoods within the proposed Planning Area that do not have access to sanitary sewer and are on septic tanks. Please see Chapter 2, Section I, Part 10 for a more in-depth discussion of septic tanks, as well as Table 5-4 in this Chapter for a list of the neighborhoods on septic tanks.



OHIO RIVER
KY-228
KY-1692
KY-79
KY-710
BYPASS RD
KY-448
KY-933
N
Pump Station Legend
1 #2 BETTER MOBILE LIVING
2 #3 BETTER MOBILE LIVING
3 2 PUMP STATION 1692
4 B-DURY ELEM SCHOOL
5 BANK STATION
6 BRANDENBURG BYP
7 BYPASS PUMPING STATION
8 DONNA DRIVE
9 FAIR GROUNDS ROAD
10 HIGH SCHOOL
11 HIGH STREET
12 HIGHWAY 933
13 HWY 710
14 KFC/TACO BELL/LONG JOHN SILVERS
15 LISA DRIVE
16 LUSK LN
17 MICHAEL LN
18 MIDDLE SCHOOL
19 NORTH MAIN LIFT STATION
20 RIVER BLUFF BEACH RD
21 RIVERPORT A
22 RIVERPORT B
23 SCHOOL SIDE DR
24 WORLEY LN
Legend
Brandenburg WWTP
Planning Area Boundary
Brandenburg City Limits
Roads
Pump Station
City of Brandenburg
Private
Grinder Pump
Commercial Light
Industrial
Institutional
Other
Residential
Manhole
Outfall
Gravity Sewer
8-inch
10-inch
Force Main
2-inch
4-inch
6-inch
8-inch
10-inch
0 1,500 3,000 Feet
Exhibit 5-1
Existing Collection System and Treatment Plant
WASTEWATER FACILITIES PLAN
CITY OF BRANDENBURG, KENTUCKY
engineering | architecture | geospatial

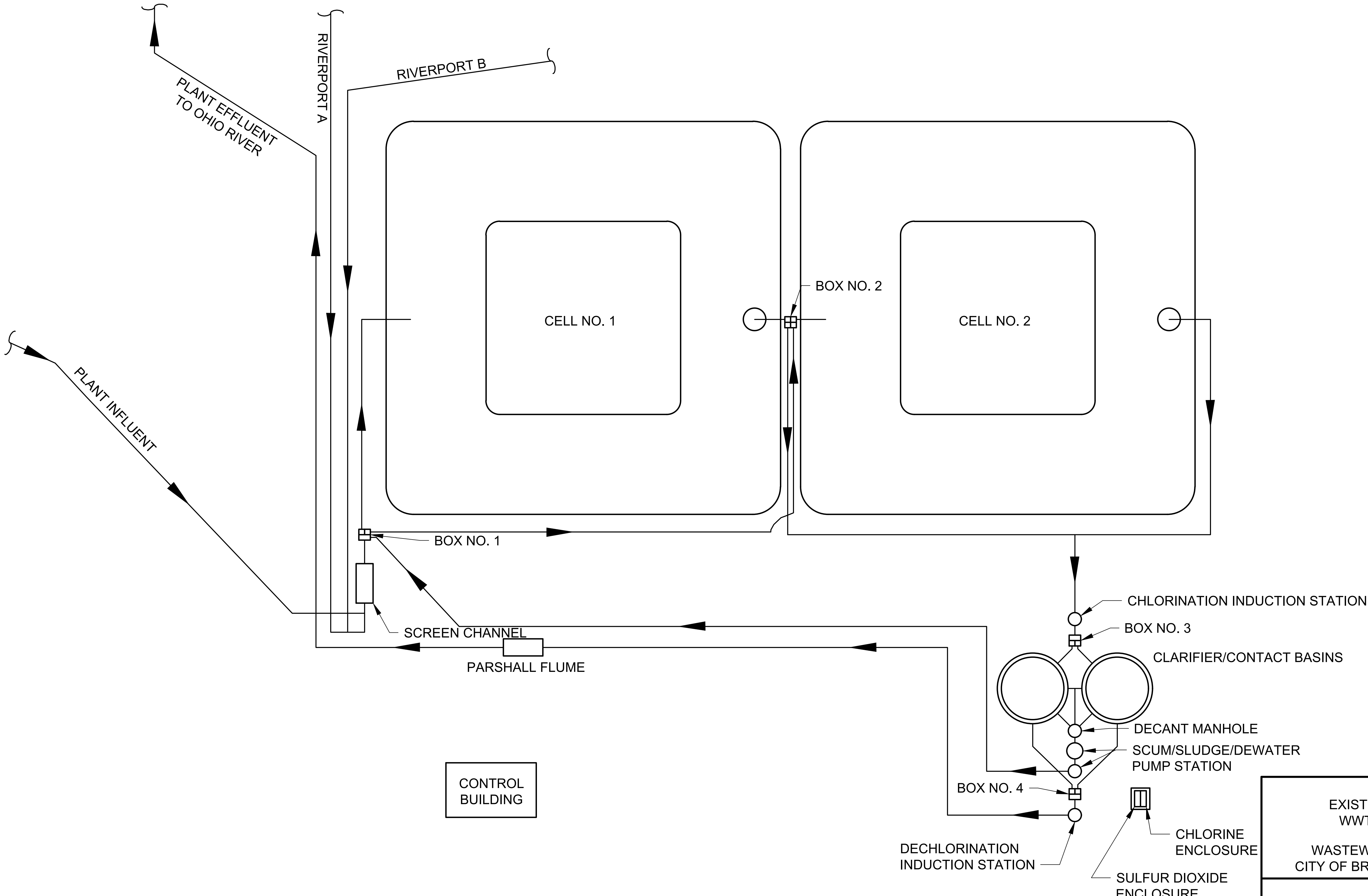


EXHIBIT 5-2
EXISTING BRANDENBURG
WWTP FLOW DIAGRAM

WASTEWATER FACILITIES PLAN
CITY OF BRANDENBURG, KENTUCKY

engineering | architecture | geospatial

FILE NAME: G:\4556-Bburg WW Plan\01-WW Plan Update\Working Drawings\AutoCAD\Exhibit 5-2 - Existing Flow Schematic.dwg

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Chapter 6
Alternatives

A. *Introduction*

The present worth analysis method was used in evaluating the cost effectiveness of the various alternatives. For the purposes of determining salvage values for structures, equipment, and piping, it was assumed that: structures were 40% of their original value after 20 years, equipment was 0% of its original value after 20 years, and piping was 50% of its original value after 20 years. A discount rate of 2.875% was used in the present worth analysis as set annually by the Department of the Interior's Bureau of Reclamation. This discount rate is used for the period October 1, 2016, through and including September 30, 2017.

Non-monetary effectiveness, including implementability, environmental impact, engineering evaluation, public support and regionalization, was also used in evaluating the alternatives.

Preliminary design calculations that were used in evaluating alternatives are located in Appendix K.

B. *Treatment Alternatives*

The purpose of this section is to define and evaluate the available treatment alternatives for the wastewater treatment plant in order to determine the most environmentally sound, cost effective and readily implementable wastewater treatment system which will meet all applicable federal, state and local requirements for Brandenburg, Kentucky Planning Area.

The current wastewater treatment plant capacity is 0.312 MGD average daily flow (ADF) and 0.932 MGD peak hydraulic flow (PHF). The 2037 design flows are 0.268 MGD ADF and 0.439 MGD PHF. As such, the treatment alternatives will not be increasing the existing WWTP capacity.

As previously mentioned, the City of Brandenburg entered into an Agreed Order to address there numerous permit violations from May 2011 to December 2015. The various treatment alternatives evaluated in the following sections were selected to bring Brandenburg's WWTP back into compliance with their KPDES permit limits.

1. Influent Design Parameters

All alternatives will be designed based on the influent parameters listed in Table 6-1.

Table 6-1
2037 Brandenburg WWTP
Influent Design Parameters

Influent Parameter	Value
Average Daily Flow	0.312 MGD
Peak Hydraulic Flow	0.932 MGD
BOD_5	1052 lbs/day
BOD_5	404 mg/l
TSS	1000 lbs/day
TSS	384 mg/l
Ammonia-Nitrogen	70 lbs/day*
Ammonia-Nitrogen	27 mg/l*

*Based on the original WWTP design. It is recommended that the City begin sampling influent ammonia-nitrogen to determine if this value has changed. If so, the design will be adjusted accordingly.

The background for the influent design parameters were previously discussed in Chapter 4.

2. Wastewater Treatment Plant Effluent Limits and Reliability Requirements

The Kentucky Division of Water (KDOW) performed a waste load allocation analysis for Brandenburg's WWTP in April of 2017.

The proposed KPDES permit effluent limits and reliability requirements based on the waste load allocation analysis are presented in Appendix E and below Table 6-2.

Table 6-2
Proposed Monthly Average KPDES Permit Limits and Reliability Requirements

Effluent Parameter	Value
BOD_5	30 mg/l
TSS	30 mg/l
Ammonia-Nitrogen	20 mg/l
Dissolved Oxygen (min.)	2 mg/l
Total Residual Chlorine	0.019 mg/l
Total Nitrogen	Monitor
Total Phosphorus	Monitor
E. Coli	130 mg/l
Reliability Classification	Grade C

The selected treatment alternative will be designed to comply with the proposed KPDES effluent limits and reliability requirements. The plant does not currently have a Total Phosphorus limit, but is required to monitor plant effluent for Total Phosphorus (mg/l). Brandenburg's WWTP is not expected to have a Total Phosphorus limit due to the outfall being located on the Ohio River. If the WWTP receives a Total Phosphorus limit, new treatment processes may be required to meet the limit requirements.

3. Treatment Alternatives

Six treatment alternatives (including a "No Action" alternative) were developed to meet Brandenburg's KPDES effluent limits. Three of the alternatives were considered environmentally sound, cost effective, and readily implementable. As a result they were studied further. The other three didn't meet this criteria and an in-depth analysis wasn't performed. The treatment alternatives that were evaluated are:

Alternative 1 – Addition of Polishing Reactor

This alternative is the simplest alternative from an operations standpoint based on the fact that the treatment process will remain the same with the addition of a polishing reactor. The existing lagoons existing sludge capacity currently exceeds design storage capacity. The lagoons will be desludged and relined. The removal of the sludge should reduce the effluent TSS and eliminate the ammonia-nitrogen re-release being caused by the existing sludge. The polishing reactor will provide additional ammonia-nitrogen removal to meet the current effluent limits during the cold weather months when the lagoons can't meet permit requirements. The existing clarifiers will no longer act as chlorine contact basins, thus eliminating the return of dead "bugs" to the lagoons and upsetting the biology of the plant.

See Appendix L for more information on the polishing reactor. Exhibit 6-1.1 provides the plant layout and Exhibits 6-1.2 to 6-1.5 provide the financial analysis for Alternative 1. Alternative 1 includes the following elements:

- Existing Screening
  - New mechanical inline grinder/screen/compactor
  - Remove existing manual bar screen and replace with existing mechanical inline grinder/screen/compactor
  - Raise weir plate height

- Existing Lagoon Cell No. 1 and 2
  - Dewater, remove sludge and liner, and dispose of sludge and liner
  - New liner
  - New DO probes

- New Polishing Reactor including concrete structure, media, diffusers, and blowers

- Existing Clarifiers
  - Replace drive unit for west clarifier
  - Replace weir and scum baffle, skimmer assembly, rake arm, feedwell baffle, current density for east and west clarifiers
  - New pressure relief valves for east and west clarifiers

- New Disinfection Contact Tank including concrete structure and slide gates.

- New Peracetic Acid Disinfection Feed System including pump skid and eyewash shower.

- New Chemical Feed System to assist with setting of solids including peristaltic pumps, shelter, TSS probe, and miscellaneous piping.

- Site piping, road work, and miscellaneous equipment.

- Electrical and instrumentation/SCADA.

- Emergency generator

Elements of this alternative that add value, but are not necessary for the Brandenburg WWTP to meet compliance standards, include: concrete and/or grating repairs at the existing screening, Box No. 1, and parshall flume, blast and painting bridge, clarifier mechanisms, piping, and handwheel operators and stand, replacing gate valve in decant manhole, replacing flow dispersal pier and rip rap at outfall, replacing ceiling tiles in control building, and new site lighting.

Alternative 2 – Waving Biomedia

Alternative 2 includes installing new microbubble aeration equipment and waving biomedia to Lagoon No. 1. Lagoon No. 1 and 2 will be desludged. Lagoon No. 1 would be relined and repurposed from a one cell lagoon to a three cell. The three cells include: a well-mixed aerobic, a plug flow anoxic, and settling cell. The well-mixed aerobic cell includes the existing aerators, waving biomedia, and new aeration nozzles. The new aeration nozzles will create microbubble aeration and aerate in the opposite direction of the influent flow. The plug flow anoxic zone includes additional waving biomedia. The final cell is a settling cell for sludge accumulation and storage. The three cell Lagoon No. 1 will provide the necessary treatment of BOD_5, TSS, and ammonia-nitrogen to meet the effluent permit limits. The three cell process eliminates the need for the existing Lagoon Cell No. 2 and clarifiers, which will be abandoned.

See Appendix L for more information on the microbubble aeration equipment and waving biomedia. Exhibit 6-2.1 provides the plant layout and Exhibits 6-2.2 to 6-2.5 provide the financial analysis for Alternative 2. Alternative 2 includes the following elements:

- Existing Screening
  - New mechanical inline grinder/screen/compactor
  - Remove existing manual bar screen and replace with existing mechanical inline grinder/screen/compactor
  - Raise weir plate height

- Existing Lagoon Cell No. 1
  - Dewater, remove sludge and liner, and dispose of sludge and liner
  - New liner
  - New microbubble aeration equipment and waving biomedia
  - New DO probes

- Existing Lagoon Cell No. 2
  - Dewater, remove sludge and liner, and dispose of sludge and liner

- New Disinfection Contact Tank including concrete structure and slide gates.

- New Peracetic Acid Disinfection Feed System including pump skid and eyewash shower.

- New Chemical Feed System to assist with setting of solids including peristaltic pumps, shelter, TSS probe, and miscellaneous piping.

- Site piping, road work, and miscellaneous equipment.

- Electrical and instrumentation/SCADA.

- Emergency generator

Elements of this alternative that add value, but are not necessary for the Brandenburg WWTP to meet compliance standards, include: concrete and/or grating repairs at the existing screening, Box No. 1, and parshall flume, replacing flow dispersal pier and rip rap at outfall, replacing ceiling tiles in control building, and new site lighting.

Alternative 3 – Diffusers and Polishing Reactor

Alternative 3 includes installing new aeration equipment to Lagoon No. 1 and a polishing reactor. Lagoon No. 1 and 2 will be desludged. Lagoon No. 1 would be relined and repurposed from a one cell lagoon to a two cell. The two cells include: complete mix and settling cell. The complete cell includes high rate diffusers. The complete mix and settling cell are divided by a hydraulic baffle with a window to prevent short circuiting. The settling cell includes low rate diffusers, allowing for sludge accumulation and storage. The two cell lagoon will provide the necessary treatment of BOD_5, TSS, and ammonia-nitrogen to meet the effluent permit limits. The polishing reactor will provide additional ammonia-nitrogen removal to meet the current effluent limits during the cold weather months when the lagoons effluent needs additional treatment to meet permit requirements. The two cell process eliminates the need for the existing Lagoon Cell No. 2 and clarifiers which will be abandoned.

See Appendix L for more information on the diffusers, baffle, and polishing reactor. Exhibit 6-3.1 provides the plant layout and Exhibits 6-3.2 to 6-3.5 provide the financial analysis for Alternative 3. Alternative 3 includes the following elements:

- Existing Screening
  - New mechanical inline grinder/screen/compactor
  - Remove existing manual bar screen and replace with existing mechanical inline grinder/screen/compactor
  - Raise weir plate height

- Existing Lagoon Cell No. 1
  - Dewater, remove sludge and liner, and dispose of sludge and liner
  - New liner
  - New low and high rate diffusers and baffle
  - New DO probes

- Existing Lagoon Cell No. 2
  - Dewater, remove sludge and liner, and dispose of sludge and liner

- New Polishing Reactor including concrete structure, media, diffusers, and blowers

- New Disinfection Contact Tank including concrete structure and slide gates.

- New Peracetic Acid Disinfection Feed System including pump skid and eyewash shower.

- Site piping, road work, and miscellaneous equipment.

- Electrical and instrumentation/SCADA.

- Emergency generator

Elements of this alternative that add value, but are not necessary for the Brandenburg WWTP to meet compliance standards, include: concrete and/or grating repairs at the existing screening, Box No. 1, and parshall flume, replacing flow dispersal pier and rip rap at outfall, replacing ceiling tiles in control building, and new site lighting.

Alternative 4 – "Greenfield" Lagoon

Alternative 4 included the same technology proposed by Alternative 3. The difference between the two alternatives was that Alternative 4 proposed constructing a new lagoon on the existing WWTP site instead of repurposing the existing Lagoon Cell No. 1. After completing preliminary construction costs and discussing the alternative with the City of Brandenburg. It was deemed that further analysis was not warranted.

Alternative 5 – Oxidation Ditch

Alternative 5 proposed a new biological treatment process at the existing Brandenburg WWTP. The biological treatment process would replace the existing lagoons with an oxidation ditch. The alternative would also require aerated sludge holding, sludge dewatering and disposal, and would be more complicated to operate than the other alternatives. After completing preliminary construction costs and discussing the alternative with the City of Brandenburg. It was deemed that further analysis was not warranted.

Alternative 6 – No Action

As previously mentioned, the City of Brandenburg entered into an Agreed Order with the Common of Kentucky Energy and Environment Cabinet Division of Enforcement in June 2016 due to permit valuations from May 2011 to December 2015. One of the remedial measures within the Agreed Order was for the City to submit a CAP to the DENF. The CAP recommended updating the WWTP in accordance with the recommendations made within the updated Facilities Plan. For these reasons, the "No Action" alternative isn't an acceptable alternative and was eliminated from consideration.

Preferred Biological Treatment Alternative Based on Present Worth Analysis

Exhibit 6-10 provides a cost summary of the treatment alternatives that were evaluated. Alternative 3 – Diffusers and Polishing Reactor – is the preferred alternative due to the lowest present worth cost.

4. Disinfection Alternatives

Three alternatives were evaluated for disinfecting the Brandenburg WWTP. The disinfection alternatives that were evaluated are:

Alternative 1 – Ultraviolet (UV) Light Disinfection

This alternative involves installation of an Ultraviolet (UV) Light disinfection system. UV disinfection involves a bank of lamps emitting UV wavelength light which interacts with and disinfects the microbes in the water. The UV system (low pressure, high intensity) is capable of disinfecting certain bacteria and viruses (such as Cryptosporidium, Giardia lamblia, Coliform, Leptospira Interrogans, Salmonella Typhosa, Hepatitus, Influenza, etc.) without affecting the water's pH value.

UV disinfection would eliminate the need to store 150-pound cylinders of chlorine gas and sulfur dioxide at the plant. This would result in improved safety at the plant, as well as in the vicinity of the plant. The UV lamps must be cleaned to prevent build-up of material on the lamps. UV disinfection does require relatively large amounts of energy to power the lamps when compared to chlorination / dechlorination. Additionally, replacement of UV lamps, ballasts, and cleaning systems (i.e., wipers) are required to maintain the system. The cost estimates and present worth analysis for the UV light disinfection alternative are contained in Exhibits 6-4.1 to 6-4.4. Appendix L contains more information on the UV disinfection system. The Brandenburg WWTP would require two banks of UV lamps to meet redundancy requirements, with 4 modules per bank and 4 lamps per module for a total of 32 UV lamps. A new concrete channel would be needed, as well.

Alternative 2 – Peracetic Acid

This alternative involves installation of a Peracetic Acid (PAA) disinfection system. The system involves using PAA, resulting from an equilibrium reaction of acetic acid and hydrogen peroxide, to kill microbial organisms in the wastewater. PAA kills microbial organisms, such as fecal coliforms and E. coli by disruption of cell membranes. It has a lower aquatic toxicity than chlorine and decays rapidly in the environment, which results in PAA not requiring a quenching step.

PAA disinfection would eliminate the need to store 150-pound cylinders of chlorine gas and sulfur dioxide at the plant. This would result in improved safety at the plant, as well as and in the vicinity of the plant. The system will include peristaltic pumps, piping, totes of chemical with spill containment, and construction of a contact tank after settling. The cost estimates and present worth analysis for the PAA disinfection alternative are contained in

Exhibits 6-5.1 to 6-5.4. Appendix L contains more information on the PAA disinfection including a bench scale test performed by PeroxyChem on Brandenburg's WWTP. The plant conducted a pilot study using PAA beginning on May 2016 and proceeding for six months. A copy of the pilot application to KDOW can be seen on Appendix F.

Alternative 3 – Chlorine

This alternative involves maintaining the WWTP's current disinfection system. Brandenburg's WWTP currently uses the existing clarifiers as a chlorine contact tank. A chlorine contact tank will be constructed after the settling to meet Ten State Standards and KDOW requirements. A new dechlorination induction station will be constructed. The existing chlorination/ dechlorination equipment and enclosure are showings signs of corrosion and will require replacements. This option would require the continued use of 150-pound cylinders of chlorine and sulfur dioxide which pose a potential safety risk at the plant and in the vicinity of the plant. The cost estimates and present worth analysis for the chlorination/dechlorination alternative are contained in Exhibits 6-6.1 to 6-6.4.

Selected Disinfectant Alternative

Exhibit 6-10 provides a cost summary of the disinfection alternatives that were evaluated. Alternative 1 – UV Disinfection is the lowest present worth cost. Based on City preference, the positive results from the PAA pilot, and the unknown effluent transmissivity that could affect UV, the selected disinfectant alternative is Alternative 2 – Peracetic Acid. Additional future analysis will be performed on the WWTP effluent, which could confirm UV being a viable alternative and result in the selected disinfectant changing. A formal amendment to the Facilities Plan would be submitted to KDOW if the selected alternative changes. Advantages of both disinfectants include: elimination of 150-pound cylinders of chlorine and sulfur dioxide and reduced corrosion due to chlorine.

5. Cost Effective Analysis

The present worth value method was used to determine the most cost effective alternatives. Initial capital costs, O&M costs and salvage values were used to calculate the present worth value.

The results of the cost effective analysis for biological treatment alternatives were previously discussed in Exhibits 6-1.2 through 6-3.5.

Note that for each biological treatment alternative, three sub-alternatives were analyzed for disinfection (Exhibits 6-4.1 through 6-6.4). Alternative 3 – PAA Disinfection – was used in the evaluation of the biological treatment alternatives.

A summary of the biological treatment alternatives cost effectiveness as well as the disinfection alternatives cost effectiveness are presented in Exhibit 6-10.

Exhibit 6-10 reveals that the Diffusers and Polishing Reactor (Alternative 3) is the most cost effective biological treatment alternative. This monetary effectiveness analysis will be considered along with a non-monetary effectiveness evaluation later in this chapter to select the preferred biological treatment alternative.

C. ***Sustainable Design***

The industry standard for determining the sustainable or "green" attributes of a given design is the Leadership in Energy and Environmental Design (LEED) Certification Process, as put forth by the United States Green Building Council (USGBC). All projects should involve efficient use of energy as part of the basic design, regardless of whether or not the owner is looking to have it officially LEED certified. In the case of new treatment plants, there are numerous opportunities to design energy efficient equipment and processes.

The LEED rating systems are based on accepted energy and environmental principles that strike a balance between known established practices and emerging concepts. These emerging concepts are organized into five environmental categories plus a "bonus" innovative design category. The five basic categories include: sustainable sites, water efficiency, energy and atmosphere, materials resources, and indoor environment quality.

Some “green” design features that are applicable to a wastewater treatment plant site might include variable frequency drives (VFDs) on equipment such as pumps and aerators, energy efficient lighting, rain gardens and infiltration swales to help both clean and slow down storm water, pervious pavement or permeable pavers to reduce impervious surface area, cisterns to store water for irrigation purposes, restoration of native grasses and wildflowers to limit the need for watering and for erosion control, and the re-establishing or enhancement of stream riparian buffers. More ambitious projects could involve “green” elements such as vegetated roofs to reduce heat island effect and increase energy efficiency, or turbines at the bottom of the cascade aeration steps to produce electricity for use at the plant or for sale back to the power provider.

D. Non-Monetary Effectiveness Analysis

In planning new wastewater treatment facilities non-monetary effectiveness issues as well as monetary criteria need to be used in determining the preferred alternative.

This section includes a general evaluation of the three proposed biological treatment alternatives to determine which solution will maximize non-monetary effectiveness. The discussion will focus on the following categories:

- Environmental Impact
- Engineering Evaluation
- Implementability
- Energy Consumption
- Expandability
- Chemical Use
- Public Support
- Institutional & Legal Capability
- Regionalization
- Land Purchase & Easements

The non-monetary effectiveness ratings for the three biological treatment alternatives can be found in Exhibit 6-11. Following is a brief discussion of each of the above categories:

1. Environmental Impact

Each alternative was selected on the basis of its ability to achieve the planning area's wastewater treatment and water quality goals and objectives, and the ability to comply with requirements of the Kentucky Division of Water. The two primary periods when the environment could be damaged are during construction or during a major treatment process upset (assuming all alternatives considered will consistently meet permit discharge limits).

All three alternatives require approximately the same amount of construction and all construction for these three alternatives would take place on the existing plant.

For all options, construction procedures would include methods to safeguard the environment such as silt fences and proper material storage. The wastewater treatment plant is a reasonable distance from residential and commercial facilities and construction noise, dust, odor and traffic are not anticipated to be problems.

Regarding plant upsets, Alternatives 1, 2, and 3 are well established processes that plant operators are familiar with and plant upsets are not expected to pose a significant problem.

Overall, there is not expected to be a significant difference between the three Alternatives regarding environmental impact. All alternatives are considered equivalent for this category.

2. Engineering Evaluation

The primary goal of the selected alternative is to provide the most cost effective, environmentally sound and implementable wastewater treatment plant capable of achieving the Brandenburg Planning Area's water quality and service goals.

Alternatives 1 through 3 are all fully capable of meeting the requirements of the Planning Area. Alternatives 1 and 3 are based on a proven process with multiple installations across the state and country. Alternative 2 uses new technology that has not been proven at a municipal WWTP.

The reliability of each of the alternatives is based on the long term operation of the various components of the mechanical systems which comprise the treatment process. The reliability of these systems is dependent on the quality of the manufacturer's equipment, the quality of initial installation and the implementation of satisfactory maintenance and preventive maintenance programs by the City of Brandenburg. Assuming that each of these considerations are addressed, each alternative will have the capability of long term reliability for the design life of the project.

Alternatives 1 and 3 have a proven history of reliability. Alternative 2 is a new technology that doesn't have historical data showing reliability.

3. Implementability

The ability to implement each alternative from both constructability and operational perspectives was considered in the evaluation of each of the respective alternatives.

From a constructability perspective, the three alternatives would require the similar amount of construction and disruption to the current plant operations. Each alternative would require each of the existing lagoons to be taken out of service at a time during construction. The WWTP was design with full redundancy.

From an operational perspective, Alternative 1 would keep the same operations with the addition of a polishing reactor. Alternatives 2 and 3 would change the aeration system and equipment.

4. Energy Consumption

Each alternative has distinctive energy requirements which are primarily based on cost and environmental impact. Alternative 3 (Diffusers and Polishing Reactor) is the most energy efficient process. Alternative 1 (Addition of Polishing Reactor) and Alternative 2 (Waving Biomedia) are slightly less energy efficient.

5. Expandability

The capability of the new process units to accommodate future expansion is an important consideration. Alternative 2 and 3 are the most readily expanded process since the abandoned Lagoon No. 2 can be repurposed with the equipment used in Lagoon No. 1. Alternative 1 is the least expandable since it would require construction of a third lagoon. The WWTP site has the available land to accommodate a third lagoon to the south of the control building.

6. Chemical Use

Each alternative will require chemical usage for disinfection. Alternative 3 will only use chemicals for disinfection. Alternatives 1 and 2 will potentially need additional chemical feed, such as Alum, during high TSS scenarios to assist with the settling of solids. All three alternatives eliminate the existing 150-pound chlorine and sulfur dioxide storage cylinders.

7. Public Support

In order to address the public's interest the City conducted a public hearing to inform the public of the needs of the treatment system and to discuss the proposed treatment alternatives. At the meeting, projected construction and operations costs were discussed and their projected effect on sewer rates. The minutes and attendance roster of the public hearing are included in Appendix J.

The public acceptability of Alternatives 1 to 3 are similar because the City's wastewater infrastructure needs would be met by all three options.

8. Institutional and Legal Capability

The City of Brandenburg has the institutional and legal capability to undertake any of the alternatives presented. All alternatives are considered equivalent for this category.

9. Regionalization

The contribution that the alternative make towards regional wastewater collection and treatment is important. All alternatives contribute to regionalization by providing wastewater collection and treatment service to the regional planning area.

All alternatives are considered equivalent for this category.

10. Land Purchase and Easements

All alternatives can be implemented on the existing plant site. No purchase of new land and no easements should be required for any of the alternatives. All alternatives are considered equivalent for this category.

11. Summary of Non-Monetary Effectiveness Analysis

Exhibit 6-11 provides non-monetary effectiveness ratings for each treatment alternative and compares the alternatives based on non-monetary effectiveness units (NEUs). Alternative 3 – Diffusers and Polishing Reactor has the lowest NEU score (132,271) and would be the preferred treatment alternative based on Non-Monetary Effectiveness Analysis.

E. Collection System Alternatives

1. Purpose

The purpose of this section is to define and evaluate the available alternatives for expanding the existing wastewater collection system to accommodate the projected 2037 wastewater flows to be transported by the sewage collection system. As shown in the following sections, new gravity collector sewers are proposed to currently un-served areas to expand the collection system by the end of the planning period.

2. Definition of Alternatives

Three collection system upgrade alternatives were considered for accommodating Brandenburg's proposed collection system expansion. The collection system expansion alternatives that were considered include: 1) Conventional Gravity Collection System, 2) Vacuum Collection System, and 3) Low Pressure Collection System.

Alternative 1 – Conventional Gravity Collection System

Traditionally, wastewater collection systems consist of gravity sewers, pump stations and force mains. Although considered "low technology" when compared to alternative forms of waste collection, it is a tried-and-true method which a majority of municipalities employ. Brandenburg has had a conventional gravity system in place for roughly 55 years, since the early 1960s.

Alternative 2 – Vacuum Collection System

Vacuum sewage transport utilizes differential air pressure to create flow, as opposed to the gravity induced flow of conventional wastewater collection systems. A vacuum sewer system consists of three major components: the valve pit installation; vacuum collection and transmission conduits (service lines, branch lines, and mains), and the vacuum collection station. When a preset quantity of sewage flows into the valve pit a pneumatic signal is sent to the controller mounted on the interface valve, which is then opened by the vacuum. The valve stays open for a preset amount of time allowing the sewage to be drawn into the vacuum lines. Sewage is propelled through the lines at a velocity of 15-18 feet per second by energy created from the sewage/air mixture. The propulsive force's magnitude declines noticeably when the valve closes, but remains important as the admitted air continues to expand. Within seconds, friction slows the sewage and flow continues under the influence of gravity. Eventually, all motion ceases until the next valve cycles.

Sewage is drawn into the vacuum mains and into a collection tank by vacuum pumps. The collection tank and vacuum pumps are located in the vacuum collection/pumping station. As the tank fills, sensing rods activate the sewage pumps which, in turn, pump the sewage to a gravity interceptor sewer, wastewater pumping station, or wastewater treatment plant.

The vacuum collection system is most practical for small communities that lie on hilly terrain.

Alternative 3 – Low Pressure Collection System

The low pressure collection system is also most practical for small communities that lie on hilly terrain. Each house has an individual grinder pump that reduces waste to a finely ground slurry. The waste is then pumped through a common force main to a wastewater treatment facility. More often than not, there is no need for any lift or auxiliary pumping stations. In addition, infiltration and inflow problems are often eliminated, and the high efficiency pumps used require lower power operating costs than many typical major home appliances.

3. Collection System Alternative Selection

Although vacuum and low pressure wastewater collection systems can be sound alternatives to a conventional gravity sewer system, they were not considered to be viable alternatives for the Brandenburg collection system. The reasons are that the City of Brandenburg has had a conventional gravity sewer system since the early 1960s, and to convert to an alternate form of technology would be both time consuming and expensive. In addition, maintenance on a new type of system would require additional training of a staff that is already experienced with the existing conventional gravity system. Therefore, the selected wastewater collection system alternative will consist of additions to the existing gravity sewer system.

5. Proposed Collection System Expansion

The potential expansion of the City of Brandenburg's Collection System has been broken out into the 3-10 year and 11-20 year planning phases. During the 0-2 year planning phase, the City will be completing upgrades at the WWTP. The 3-10 year and 11-20 year planning phases are expanding into areas that are currently on Brandenburg's water system. The City may or may not choose to serve these potential customers, but since they are currently on the City's water system they would be the next logical locations for the City to expand.

A hydraulic model wasn't completed for the existing or proposed collection system for this Facilities Plan. If the City proceeds with designing and constructing the following planning phases, the completion of a hydraulic model is recommended. A hydraulic model would help establish capacity issues that exist with the system. In addition to CCTV identifying the areas that would potentially need to be replaced or rehabilitated, the model would be useful in establishing which sewers require upsizing.

a. 3-10 Year Planning Phase

Table 6-3 below summarizes the proposed 3-10 year expansion to the existing Brandenburg Collection System. The planning phase consists of two existing neighborhoods, located south of the existing service area. See Exhibit 2-6 for the Planning Area Phasing. In order to serve the neighborhoods, a combination of gravity sewer and force main will be required. The Four Oaks Road neighborhood will serve 22 houses along Four Oaks Road, Miles Lane, and Bruno Circle. A 4" force main from the neighborhood will tie into the collection system at a manhole near Armory Place. The Quail Run and Knollwood Road neighborhood will serve 83 houses along Old State Road, Knollwood Road, Kelly Lane, Quail Run Road, Oakwood Drive, Rebecca Court, and Blaine Court. A 4" force main from the neighborhood will tie into the collection system at a manhole off Old State Road.

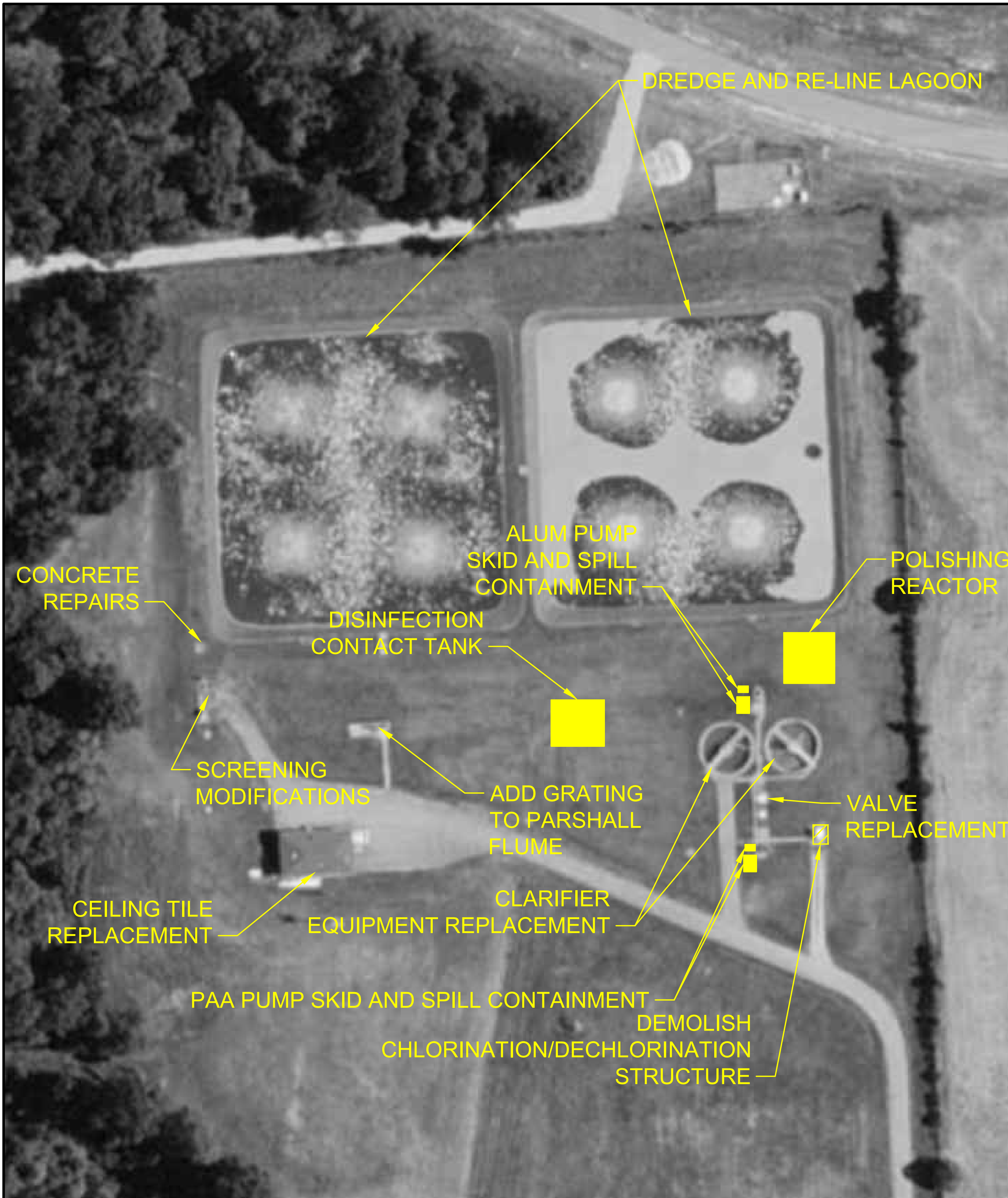
Table 6-3
3-10 Year Planning Phase
Proposed Collection System Expansion

Four Oaks Road Neighborhood		
Gravity Sewer	8"	2,440'
Force Main	2"	910'
	4"	1,640'
Duplex Lift Stations	2	
Quail Run and Knollwood Road Neighborhood		
Gravity Sewer	8"	11,770'
Force Main	4"	2,810'
Duplex Lift Stations	7	

c. 11-20 Year Planning Phase

Table 6-4 below summarizes the proposed 11-20 year collection system expansion to the existing Brandenburg Collection. The planning phase consists of three existing neighborhoods and potential agricultural and industrial growth. See Exhibit 2-6 for the Planning Area Phasing. The three existing neighborhoods will be served by a combination of gravity sewer and force main will be required. The potential agricultural development will not contribute flow to the collection system. The potential industrial development is located near two existing pump stations, which can likely be directly tied into from the development. The River Edge Road neighborhood will serve 21 houses along River Edge Road, River Edge Drive, and KY 228. An 8" gravity sewer from the neighborhood will tie into the collection system at the Brandenburg Bypass Pump Station. The Windsor Place and Sun Valley Road neighborhood will serve 61 houses along Fairground Road, Sun Valley Road, and Windsor Place. An 8" gravity sewer from the neighborhood will tie into the collection system at the Fairgrounds Road Pump Station. The Christian Church and Bud Wilson Road neighborhood will serve 65 houses along Christian Church and Bud Wilson Road. A 4" force main from the neighborhood will tie into the collection system at a manhole on Ready Mix Road.

Table 6-4 11-20 Year Planning Phase Proposed Collection System Expansion		
River Edge Road Neighborhood		
Gravity Sewer	8"	5,320'
Windsor Place and Sun Valley Road Neighborhood		
Gravity Sewer	8"	7,820'
Force Main	4"	2,000'
Duplex Lift Stations	1	
Christian Church and Bud Wilson Road Neighborhood		
Gravity Sewer	8"	8,780'
Force Main	2"	1,700'
	4"	4,150'
Duplex Lift Stations	7	



GRW PROJECT NO. 4556-01

ADDITION OF POLISHING REACTOR
ALTERNATIVE 1

WASTEWATER FACILITIES PLAN
CITY OF BRANDENBURG, KENTUCKY

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DATE: SEPT., 2017
SCALE: 1" = 100'
SHEET NO. EXHIBIT 6-1.1

Exhibit 6-1.2
Brandenburg Wastewater Treatment Plant
Alternative 1
Addition of Polishing Reactor
Total Project Cost Estimate

Description	Quantity	Unit	Unit Cost	Cost	Sum
Existing Screening					
Mechanical Inline Grinder/Screen/Compactor	1	EA	$59,000	$59,000	
Move Existing Mechanical Screen to Bypass Channel	1	EA	$3,000	$3,000	
Aluminum Grating	64	SF	$50	$3,200	
Equipment Installation (20%)	1	LS	$13,040	$13,040	
Weir Plate Modifications	1	LS	$3,000	$3,000	
Concrete Repair	1	LS	$5,000	$5,000	
Remove Existing Manual Bar Screen	1	LS	$1,000	$1,000	
Subtotal					**$87,240**
Existing Box No. 1					
Concrete Repair	1	LS	$5,000	$5,000	
Subtotal					**$5,000**
Existing Lagoon Cell No. 1 and 2					
New Liner and Installation (Lagoons 1 & 2)	125,600	SQ FT	$5	$628,000	
Sludge Removal and Thickening (5% Solids)	4,732	CY	$50	$236,600	
Sludge Hauling and Disposal (15% Solids)	1,725	CY	$19	$32,775	
Existing Liner Removal (Lagoons 1 & 2)	1	LS	$38,000	$38,000	
Existing Liner Disposal (Lagoons 1 & 2)	240	CY	$19	$4,560	
Regrading	2	AC	$6,000	$12,000	
Temporary Containment Area	1	LS	$25,000	$25,000	
Dewatering Lagoon to Remove Sludge	1	LS	$75,000	$75,000	
DO Probe and Installation	2	EA	$4,000	$8,000	
Subtotal					**$1,059,935**
Polishing Reactor					
Media, Diffusers, and Blowers	1	LS	$245,000	$245,000	
Equipment Installation (20%)	1	LS	$49,000	$49,000	
Soil Excavation	960	CY	$20	$19,200	
Crushed Stone	170	CY	$25	$4,250	
Reinforced Concrete Walls	110	CY	$750	$82,500	
Reinforced Concrete Slab	140	CY	$550	$77,000	
Subtotal					**$476,950**
Existing Clarifiers					
Drive Unit	1	EA	$21,000	$21,000	
Weir and Scum Baffle	2	EA	$9,000	$18,000	
Skimmer Assembly	2	EA	$11,000	$22,000	
Rake Arm	2	EA	$17,500	$35,000	
Feedwell Baffle	2	EA	$10,000	$20,000	
Pressure Relief Valve	8	EA	$2,000	$16,000	
Current Density Baffle	2	EA	$8,500	$17,000	
Equipment Installation (20%)	1	LS	$26,400	$26,400	
Field Service Visit	1	LS	$4,600	$4,600	
Blast and Paint Bridge, Clarifier Mechanism, and Piping	2	EA	$10,000	$20,000	
Paint Troughs	2	EA	$3,000	$6,000	
Subtotal					**$206,000**
Existing Decant Manhole					
Install City Purchased 8-inch Gate Valve	1	EA	$1,000	$1,000	
Blast and Paint Handwheel Operator and Stand	1	LS	$1,000	$1,000	
Subtotal					**$2,000**

Exhibit 6-1.2
(Continued)

Contact Tank					
Slide Gate	2	EA	$6,500	$13,000	
Aluminum Handrail	160	LF	$60	$9,600	
Equipment Installation (20%)	1	LS	$4,520	$4,520	
Soil Excavation	630	CY	$20	$12,600	
Crushed Stone	120	CY	$25	$3,000	
Reinforced Concrete Walls	120	CY	$750	$90,000	
Reinforced Concrete Slab	140	CY	$550	$77,000	
Subtotal					**$209,720**
PAA Disinfection					
PAA Pump Skid	1	EA	$30,000	$30,000	
Combination Eyewash Shower	1	EA	$10,000	$10,000	
Equipment Installation (20%)	1	LS	$8,000	$8,000	
Reinforced Concrete Walls (Containment)	4	CY	$750	$3,000	
Reinforced Concrete Slab (Containment)	16	CY	$550	$8,800	
Subtotal					**$59,800**
Chemical Feed					
Peristaltic Pumps	2	EA	$3,000	$6,000	
Chemical Shelter	1	EA	$5,000	$5,000	
TSS Probe	1	EA	$3,000	$3,000	
Miscellaneous Small Piping	1	LS	$2,000	$2,000	
Heat Trace Piping	1	LS	$1,000	$1,000	
Equipment Installation (20%)	1	LS	$3,200	$3,200	
Reinforced Concrete Walls (Containment)	4	CY	$750	$3,000	
Reinforced Concrete Slab (Containment)	16	CY	$550	$8,800	
Subtotal					**$32,000**
Existing Parshall Flume					
Aluminum Grating	86	SF	$50	$4,300	
Equipment Installation (20%)	1	LS	$860	$860	
Subtotal					**$5,160**
Existing Outfall					
Flow Dispersal Pier	1	EA	$1,000	$1,000	
Rip Rap	1	LS	$3,000	$3,000	
Subtotal					**$4,000**
Existing Control Building					
Replace Ceiling Tiles	960	SF	$6	$5,760	
Subtotal					**$5,760**
Miscellaneous Upgrades					
Demo Existing Chlorination/Dechlorination Enclosure	1	EA	$5,000	$5,000	
Bypassing Pumping	1	Month	$25,000	$25,000	
Site Dewatering	1	LS	$25,000	$25,000	
15-inch PVC Gravity Sewer	400	LF	$90	$36,000	
4-foot Dia. Precast Manhole w/ Wrap and Seal	2	EA	$5,000	$10,000	
1.5" Asphalt Overlay	383	Ton	$80	$30,653	
Subtotal					**$131,653**

Exhibit 6-1.2
(Continued)

Construction Cost Subtotal				***$2,285,218***
Mechanical, Electrical, & Instrumentation (23%)	1	LS	$526,000	**$526,000**
Subtotal				**$2,811,218**
Mobilization/Demobilization and Construction Administration (2%)	1	LS	$56,000	**$56,000.00**
Bonding and Insurance (1.5%)	1	LS	$42,000	**$42,000.00**
Contractor Overhead and Profit (12%)	1	LS	$337,000	**$337,000.00**
Subtotal				**$3,246,218**
Construction Contingencies (20%)				**$649,244**
Total Construction Cost Estimate				***$3,895,462***
Design, Bid, Construction Adminstration, Resident Project Representation, Legal, KIA Administration (20%)				**$779,000**
Total Project Cost Estimate				***$4,674,462***

Exhibit 6-1.3
Brandenburg Wastewater Treatment Plant
Alternative 1
Addition of Polishing Reactor
Annual Operation and Maintenance Cost

Item					**Annual Cost**
Labor Cost					
Salaries and Benefits	$144,000				
Total Annual Labor Cost					**$144,000**
General Cost					
Office Expenses	$12,000				
Utilities	$14,400				
Insurance	$36,000				
Telephone	$3,000				
Vehicle & Equipment Maintenance	$18,000				
Professional Fees	$8,400				
Lift Stations	$68,400				
Samples & Supplies	$21,600				
Miscellaneous	$72,000				
Total Annual General Cost					**$253,800**
New Equipment Electrical Power Usage	hp/unit	no. units	hrs/day	hp*hrs/day	
Mechanical Inline Grinder/Screen/Compactor	2	1	24	48	
Polishing Reactor Blowers	15.0	1	24	360.0	
*Total Horsepower*Hours/Day*				*408*	
Daily Power Usage	304		kw-hr/day		
Annual Power Usage	111,094		kw-hr/yr		
Power Cost	$0.070		per kw-hr		
Total Additional Annual Power Cost					**$7,777**
Disinfection Cost - Peracetic Acid (See Disinfection Alt. 2)					
Annual Peracetic Acid Cost	$11,397				
Annual Hose Replacement Cost	$2,400				
Annual Alum Cost	$1,000				
Total Annual Disinfection Cost					**$14,797**
Total Annual Operating and Maintenance Cost					**$420,374**

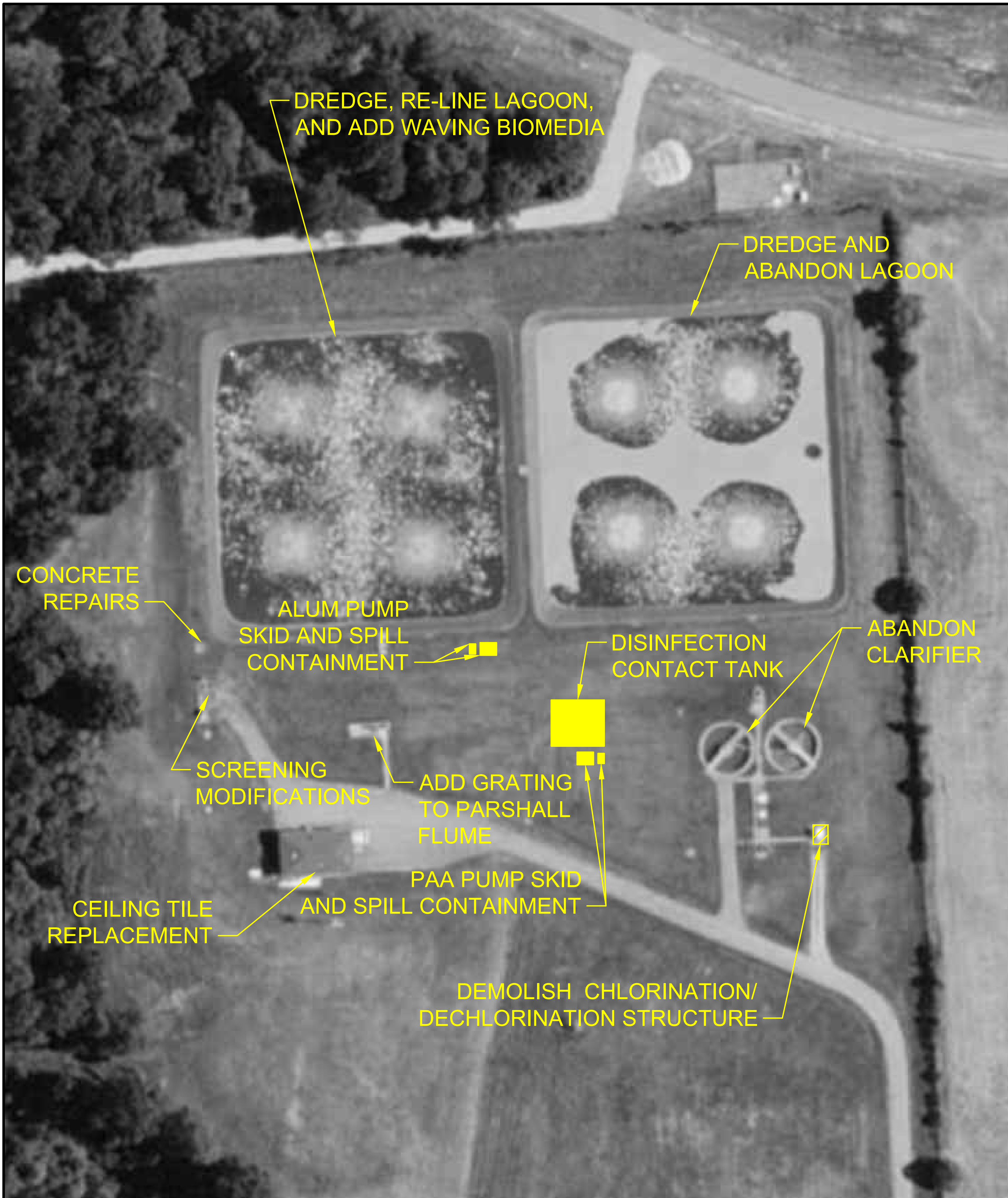
Exhibit 6-1.4
Brandenburg Wastewater Treatment Plant
Alternative 1
Addition of Polishing Reactor
20-Year Salvage Value

Description	Cost	Salvage Value
Existing Screening	$87,240	$0
Existing Box No. 1	$5,000	$0
Existing Lagoon Cell No. 1 and 2	$1,059,935	$0
Polishing Reactor	$476,950	$63,800
Existing Clarifiers	$206,000	$0
Existing Decant Manhole	$2,000	$0
Contact Tank	$209,720	$66,800
PAA Disinfection	$59,800	$4,720
Chemical Feed	$32,000	$7,720
Existing Parshall Flume	$5,160	$0
Existing Outfall	$4,000	$0
Existing Control Building	$5,760	$0
Miscellaneous Upgrades	$131,653	$18,000
Total Salvage Value		**$161,040**

Note: Equipment is assumed to have a salvage value of 0% after 20 years, structures are assumed to have a salvage value of 40% after 20 years, and pipe is assumed to have a salvage value of 50% after 20 years.

Exhibit 6-1.5
Brandenburg Wastewater Treatment Plant
Alternative 1
Addition of Polishing Reactor
Present Worth Analysis

Total Project Cost			**$4,674,462**
Present Worth of Annual Operating Cost Calculation			
Annual Operating Cost	$420,374	per year	
Discount Rate	2.875%		
Life of Project	20	years	
Present Worth of Annual Operating Cost			**$6,326,993**
Present Worth of Salvage Value			
Salvage Value	$161,040		
Discount Rate	2.875%		
Life of Project	20	years	
Present Worth of Salvage Value			**$91,356**
Approximate Total Present Worth			**$10,911,000**



GRW PROJECT NO. 4556-01

WAVING BIOMEDIA
ALTERNATIVE 2

WASTEWATER FACILITIES PLAN
CITY OF BRANDENBURG, KENTUCKY

engineering | architecture | geospatial
www.grwinc.com

DATE: SEPT., 2017
SCALE: 1" = 100'
SHEET NO. EXHIBIT 6-2.1

Exhibit 6-2.2
Brandenburg Wastewater Treatment Plant
Alternative 2
Waving Biomedia
Total Project Cost Estimate

Description	Quantity	Unit	Unit Cost	Cost	Sum
Existing Screening					
Mechanical Inline Grinder/Screen/Compactor	1	EA	$59,000	$59,000	
Move Existing Mechanical Screen to Bypass Channel	1	EA	$3,000	$3,000	
Aluminum Grating	64	SF	$50	$3,200	
Equipment Installation (20%)	1	LS	$13,040	$13,040	
Weir Plate Modifications	1	LS	$3,000	$3,000	
Concrete Repair	1	LS	$5,000	$5,000	
Remove Existing Manual Bar Screen	1	LS	$1,000	$1,000	
Subtotal					**$87,240**
Existing Box No. 1					
Concrete Repair	1	LS	$5,000	$5,000	
Subtotal					**$5,000**
Existing Lagoon Cell No. 1 and 2					
Microbubble Aeration	1	LS	$167,200	$167,200	
Waving Biomedia	1,200	EA	$100	$120,000	
Equipment Installation (20%)	1	LS	$57,440	$57,440	
New Liner and Installation (Lagoon 1 Only)	62,800	SQ FT	$5	$314,000	
Sludge Removal and Thickening (5% Solids)	4,732	CY	$50	$236,600	
Sludge Hauling and Disposal (15% Solids)	1,725	CY	$19	$32,775	
Existing Liner Removal (Lagoons 1 & 2)	1	LS	$38,000	$38,000	
Existing Liner Disposal (Lagoons 1 & 2)	240	CY	$19	$4,560	
Regrading	1	AC	$6,000	$6,000	
Temporary Containment Area	1	LS	$25,000	$25,000	
Dewatering Lagoon to Remove Sludge	1	LS	$75,000	$75,000	
DO Probe and Installation	2	EA	$4,000	$8,000	
Subtotal					**$1,084,575**
Contact Tank					
Slide Gate	2	EA	$6,500	$13,000	
Aluminum Handrail	160	LF	$60	$9,600	
Equipment Installation (20%)	1	LS	$4,520	$4,520	
Soil Excavation	630	CY	$20	$12,600	
Crushed Stone	120	CY	$25	$3,000	
Reinforced Concrete Walls	120	CY	$750	$90,000	
Reinforced Concrete Slab	140	CY	$550	$77,000	
Subtotal					**$209,720**
PAA Disinfection					
PAA Pump Skid	1	EA	$30,000	$30,000	
Combination Eyewash Shower	1	EA	$10,000	$10,000	
Equipment Installation (20%)	1	LS	$8,000	$8,000	
Reinforced Concrete Walls (Containment)	4	CY	$750	$3,000	
Reinforced Concrete Slab (Containment)	16	CY	$550	$8,800	
Subtotal					**$59,800**
Chemical Feed					
Peristaltic Pumps	2	EA	$3,000	$6,000	
Chemical Shelter	1	EA	$5,000	$5,000	
TSS Probe	1	EA	$3,000	$3,000	
Miscellaneous Small Piping	1	LS	$2,000	$2,000	
Heat Trace Piping	1	LS	$1,000	$1,000	
Equipment Installation (20%)	1	LS	$3,200	$3,200	
Reinforced Concrete Walls (Containment)	4	CY	$750	$3,000	
Reinforced Concrete Slab (Containment)	16	CY	$550	$8,800	
Subtotal					**$32,000**

Exhibit 6-2.2
(Continued)

Existing Parshall Flume					
Aluminum Grating	86	SF	$50	$4,300	
Equipment Installation (20%)	1	LS	$860	$860	
Subtotal					**$5,160**
Existing Outfall					
Flow Dispersal Pier	1	EA	$1,000	$1,000	
Rip Rap	1	LS	$3,000	$3,000	
Subtotal					**$4,000**
Existing Control Building					
Replace Ceiling Tiles	960	SF	$6	$5,760	
Subtotal					**$5,760**
Miscellaneous Upgrades					
Demo Existing Chlorination/Dechlorination Enclosure	1	EA	$5,000	$5,000	
Bypassing Pumping	1	Month	$25,000	$25,000	
Site Dewatering	1	LS	$25,000	$25,000	
15-inch PVC Gravity Sewer	400	LF	$90	$36,000	
4-foot Dia. Precast Manhole w/ Wrap and Seal	2	EA	$5,000	$10,000	
1.5" Asphalt Overlay	383	Ton	$80	$30,653	
Subtotal					**$131,653**
Construction Cost Subtotal				***$1,624,908***	
Mechanical, Electrical, & Instrumentation (23%)	1	LS	$374,000	**$374,000**	
Subtotal				**$1,998,908**	
Mobilization/Demobilization and Construction Administration (2%)	1	LS	$40,000	**$40,000.00**	
Bonding and Insurance (1.5%)	1	LS	$30,000	**$30,000.00**	
Contractor Overhead and Profit (12%)	1	LS	$240,000	**$240,000.00**	
Subtotal				**$2,308,908**	
Construction Contingencies (20%)				**$461,782**	
Total Construction Cost Estimate				***$2,770,690***	
Design, Bid, Construction Adminstration, Resident Project Representation, Legal, KIA Administration (20%)				**$554,000**	
Total Project Cost Estimate				***$3,324,690***	

Exhibit 6-2.3
Brandenburg Wastewater Treatment Plant
Alternative 2
Waving Biomedia
Annual Operation and Maintenance Cost

Item					**Annual Cost**
Labor Cost					
Salaries and Benefits	$144,000				
Total Annual Labor Cost					**$144,000**
General Cost					
Office Expenses	$12,000				
Utilities	$14,400				
Insurance	$36,000				
Telephone	$3,000				
Vehicle & Equipment Maintenance	$18,000				
Professional Fees	$8,400				
Lift Stations	$68,400				
Samples & Supplies	$21,600				
Miscellaneous	$72,000				
Total Annual General Cost					**$253,800**
New Equipment Electrical Power Usage	hp/unit	no. units	hrs/day	hp*hrs/day	
Mechanical Inline Grinder/Screen/Compactor	2	1	24	48	
Recycle Pump	25.0	1	24	600.0	
Repurposed West Lagoon Surface Aerators	15.0	4	24	1,440.0	
*Total Horsepower*Hours/Day*				*2,088*	
Daily Power Usage	1,558		kw-hr/day		
Annual Power Usage	568,542		kw-hr/yr		
Power Cost	$0.070		per kw-hr		
New Equipment Annual Power Cost				*$39,798*	
Existing Power Usage of Removed Equipment	hp/unit	no. units	hrs/day	hp*hrs/day	
West Lagoon Surface Aerators	15	4	12	720	
East Lagoon Surface Aerators	15	4	5	300	
Chlorination/Dechlorination Induction Pumps	0.5	2	24	24.0	
Clarifier Drive Units	0.5	2	24	24.0	
RAS Pumps	3.0	1	4	12.0	
*Total Horsepower*Hours/Day*				*1,080*	
Daily Power Usage	806		kw-hr/day		
Annual Power Usage	294,073		kw-hr/yr		
Power Cost	$0.070		per kw-hr		
Removed Equipment Annual Power Cost				*-$20,585*	
Total Additional Annual Power Cost					**$19,213**
Disinfection Cost - Peracetic Acid					
(See Disinfection Alt. 2)					
Annual Peracetic Acid Cost	$11,397				
Annual Hose Replacement Cost	$2,400				
Annual Alum Cost	$1,000				
Total Annual Disinfection Cost					**$14,797**
Total Annual Operating and Maintenance Cost					**$431,810**

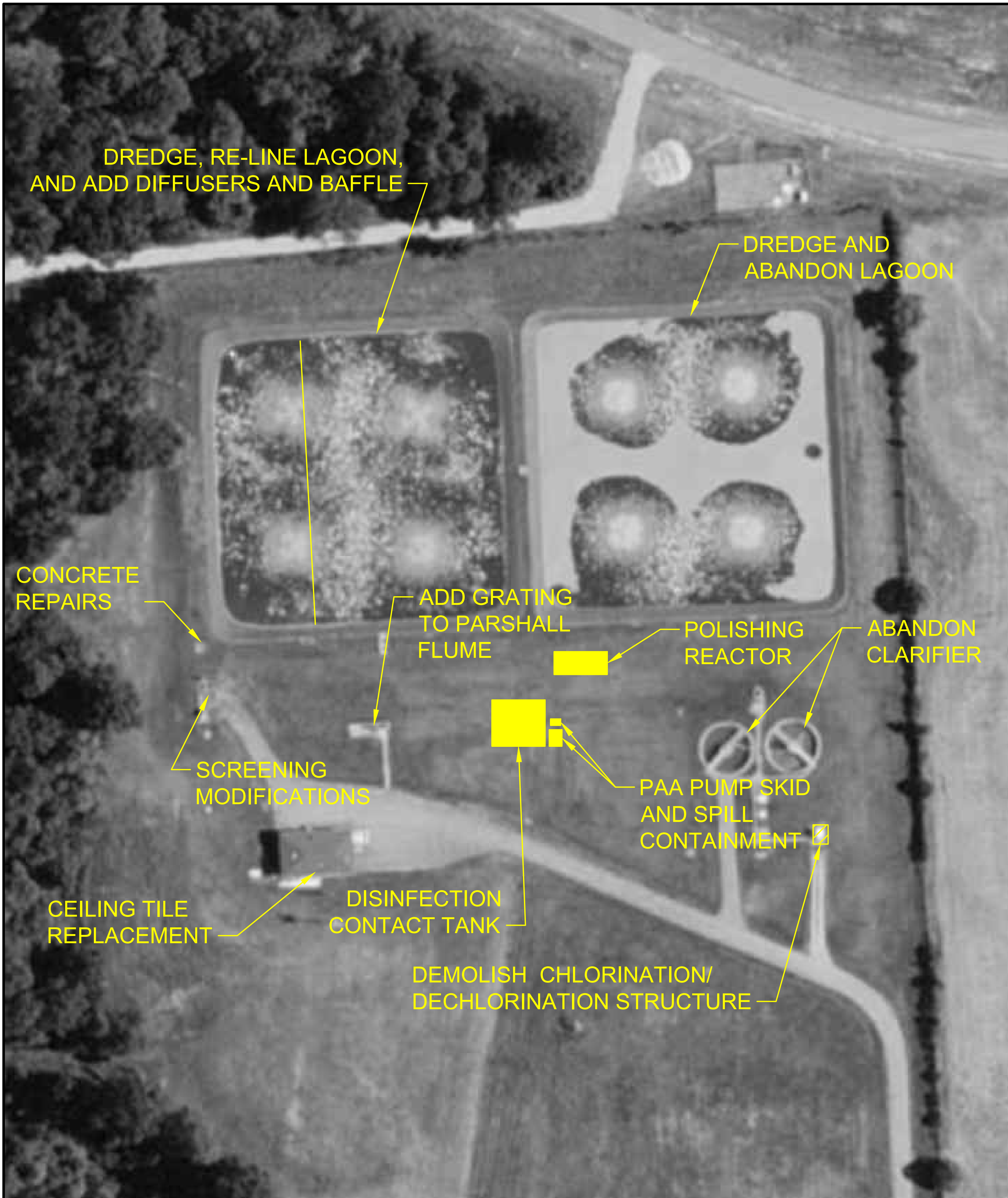
Exhibit 6-2.4
Brandenburg Wastewater Treatment Plant
Alternative 2
Waving Biomedia
20-Year Salvage Value

Description	Cost	Salvage Value
Existing Screening	$87,240	$0
Existing Box No. 1	$5,000	$0
Existing Lagoon Cell No. 1 and 2	$1,084,575	$0
Contact Tank	$209,720	$66,800
PAA Disinfection	$59,800	$4,720
Chemical Feed	$32,000	$7,720
Existing Parshall Flume	$5,160	$0
Existing Outfall	$4,000	$0
Existing Control Building	$5,760	$0
Miscellaneous Upgrades	$131,653	$14,400
Total Salvage Value		**$93,640**

Note: Equipment is assumed to have a salvage value of 0% after 20 years, structures are assumed to have a salvage value of 40% after 20 years, and pipe is assumed to have a salvage value of 50% after 20 years.

Exhibit 6-2.5
Brandenburg Wastewater Treatment Plant
Alternative 2
Waving Biomedia
Present Worth Analysis

Total Project Cost			**$3,324,690**
Present Worth of Annual Operating Cost Calculation			
Annual Operating Cost	$431,810	per year	
Discount Rate	2.875%		
Life of Project	20	years	
Present Worth of Annual Operating Cost			**$6,499,118**
Present Worth of Salvage Value			
Salvage Value	$93,640		
Discount Rate	2.875%		
Life of Project	20	years	
Present Worth of Salvage Value			**$53,121**
Approximate Total Present Worth			**$9,771,000**



GRW PROJECT NO. 4556-01

DIFFUSERS & POLISHING REACTOR
ALTERNATIVE 3

WASTEWATER FACILITIES PLAN
CITY OF BRANDENBURG, KENTUCKY

engineering | architecture | geospatial

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DATE: SEPT., 2017

SCALE: 1" = 100'

SHEET NO. EXHIBIT 6-3.1

Exhibit 6-3.2
Brandenburg Wastewater Treatment Plant
Alternative 3
Diffusers and Polishing Reactor
Total Project Cost Estimate

Description	Quantity	Unit	Unit Cost	Cost	Sum
Existing Screening					
Mechanical Inline Grinder/Screen/Compactor	1	EA	$59,000	$59,000	
Move Existing Mechanical Screen to Bypass Channel	1	EA	$3,000	$3,000	
Aluminum Grating	64	SF	$50	$3,200	
Equipment Installation (20%)	1	LS	$13,040	$13,040	
Weir Plate Modifications	1	LS	$3,000	$3,000	
Concrete Repair	1	LS	$5,000	$5,000	
Remove Existing Manual Bar Screen	1	LS	$1,000	$1,000	
Subtotal					**$87,240**
Existing Box No. 1					
Concrete Repair	1	LS	$5,000	$5,000	
Subtotal					**$5,000**
Existing Lagoon Cell No. 1 and 2					
Baffle	1	EA	$20,000	$20,000	
Aeration	1	LS	$40,000	$40,000	
Blowers	1	LS	$55,000	$55,000	
Control Panel	1	EA	$30,000	$30,000	
Equipment Installation (20%)	1	LS	$12,000	$12,000	
New Liner and Installation (Lagoon 1 Only)	62,800	SQ FT	$5	$314,000	
Sludge Removal and Thickening (5% Solids)	4,732	CY	$50	$236,600	
Sludge Hauling and Disposal (15% Solids)	1,725	CY	$19	$32,775	
Existing Liner Removal (Lagoons 1 & 2)	1	LS	$38,000	$38,000	
Existing Liner Disposal (Lagoons 1 & 2)	240	CY	$19	$4,560	
Regrading	1	AC	$6,000	$6,000	
Temporary Containment Area	1	LS	$25,000	$25,000	
Dewatering Lagoon to remove Sludge	1	LS	$75,000	$75,000	
Relocation of Lagoon 1 Influent and Effluent Piping	1	LS	$15,000	$15,000	
DO Probe and Installation	1	EA	$4,000	$4,000	
Subtotal					**$907,935**
Polishing Reactor					
Media, Diffusers, and Blowers	1	LS	$68,000	$68,000	
Cover	1	EA	$2,000	$2,000	
Equipment Installation (20%)	1	LS	$14,000	$14,000	
Soil Excavation	490	CY	$20	$9,800	
Crushed Stone	130	CY	$25	$3,250	
Reinforced Concrete Walls	90	CY	$750	$67,500	
Reinforced Concrete Slab	70	CY	$550	$38,500	
Subtotal					**$203,050**
Contact Tank					
Slide Gate	2	EA	$6,500	$13,000	
Aluminum Handrail	160	LF	$60	$9,600	
Equipment Installation (20%)	1	LS	$4,520	$4,520	
Soil Excavation	630	CY	$20	$12,600	
Crushed Stone	120	CY	$25	$3,000	
Reinforced Concrete Walls	120	CY	$750	$90,000	
Reinforced Concrete Slab	140	CY	$550	$77,000	
Subtotal					**$209,720**

Exhibit 6-3.2 (Continued)					
PAA Disinfection					
PAA Pump Skid	1	EA	$30,000	$30,000	
Combination Eyewash Shower	1	EA	$10,000	$10,000	
Equipment Installation (20%)	1	LS	$8,000	$8,000	
Reinforced Concrete Walls (Containment)	4	CY	$750	$3,000	
Reinforced Concrete Slab (Containment)	16	CY	$550	$8,800	
Subtotal					**$59,800**
Existing Parshall Flume					
Aluminum Grating	86	SF	$50	$4,300	
Equipment Installation (20%)	1	LS	$860	$860	
Subtotal					**$5,160**
Existing Outfall					
Flow Dispersal Pier	1	EA	$1,000	$1,000	
Rip Rap	1	LS	$3,000	$3,000	
Subtotal					**$4,000**
Existing Control Building					
Replace Ceiling Tiles	960	SF	$6	$5,760	
Subtotal					**$5,760**
Miscellaneous Upgrades					
Demo Existing Chlorination/Dechlorination Enclosure	1	EA	$5,000	$5,000	
Bypassing Pumping	1	Month	$25,000	$25,000	
Site Dewatering	1	LS	$25,000	$25,000	
15-inch PVC Gravity Sewer	400	LF	$90	$36,000	
4-foot Dia. Precast Manhole w/ Wrap and Seal	2	EA	$5,000	$10,000	
1.5" Asphalt Overlay	383	Ton	$80	$30,653	
Subtotal					**$131,653**
Construction Cost Subtotal				***$1,619,318***	
Mechanical, Electrical, & Instrumentation (23%)	1	LS	$372,000	**$372,000**	
Subtotal				**$1,991,318**	
Mobilization/Demobilization and Construction Administration (2%)	1	LS	$40,000	**$40,000.00**	
Bonding and Insurance (1.5%)	1	LS	$30,000	**$30,000.00**	
Contractor Overhead and Profit (12%)	1	LS	$239,000	**$239,000.00**	
Subtotal				**$2,300,318**	
Construction Contingencies (20%)				**$460,064**	
Total Construction Cost Estimate				***$2,760,382***	
Design, Bid, Construction Adminstration, Resident Project Representation, Legal, KIA Administration (20%)				**$552,000**	
Total Project Cost Estimate				***$3,312,382***	

Exhibit 6-3.3
Brandenburg Wastewater Treatment Plant
Alternative 3
Diffusers and Polishing Reactor
Annual Operation and Maintenance Cost

Item					Annual Cost
Labor Cost					
Salaries and Benefits	$144,000				
Total Annual Labor Cost					**$144,000**
General Cost					
Office Expenses	$12,000				
Utilities	$14,400				
Insurance	$36,000				
Telephone	$3,000				
Vehicle & Equipment Maintenance	$18,000				
Professional Fees	$8,400				
Lift Stations	$68,400				
Samples & Supplies	$21,600				
Miscellaneous	$72,000				
Total Annual General Cost					**$253,800**
New Equipment Electrical Power Usage	hp/unit	no. units	hrs/day	hp*hrs/day	
Mechanical Inline Grinder/Screen/Compactor	2	1	24	48	
Diffusers and Polishing Reactor Blowers	30.0	2	24	1,440.0	
*Total Horsepower*Hours/Day*				*1,488*	
Daily Power Usage	1,110		kw-hr/day		
Annual Power Usage	405,168		kw-hr/yr		
Power Cost	$0.070		per kw-hr		
Total Annual Power Cost				*$28,362*	
Existing Power Usage of Removed Equipment	hp/unit	no. units	hrs/day	hp*hrs/day	
West Lagoon Surface Aerators	15	4	12	720	
East Lagoon Surface Aerators	15	4	5	300	
Chlorination/Dechlorination Induction Pumps	0.5	2	24	24.0	
Clarifier Drive Units	0.5	2	24	24.0	
RAS Pumps	3.0	1	4	12.0	
*Total Horsepower*Hours/Day*				*1,080*	
Daily Power Usage	806		kw-hr/day		
Annual Power Usage	294,073		kw-hr/yr		
Power Cost	$0.070		per kw-hr		
Total Annual Power Cost				*-$20,585*	
Total Additional Annual Power Cost					**$7,777**
Disinfection Cost - Peracetic Acid					
(See Disinfection Alt. 2)					
Annual Peracetic Acid Cost	$11,397				
Annual Hose Replacement Cost	$2,400				
Total Annual Disinfection Cost					**$13,797**
Total Annual Operating and Maintenance Cost					**$419,374**

Exhibit 6-3.4
Brandenburg Wastewater Treatment Plant
Alternative 3
Diffusers and Polishing Reactor
20-Year Salvage Value

Description	Cost	Salvage Value
Existing Screening	$87,240	$0
Existing Box No. 1	$5,000	$0
Existing Lagoon Cell No. 1 and 2	$907,935	$0
Polishing Reactor	$203,050	$42,400
Contact Tank	$209,720	$66,800
PAA Disinfection	$59,800	$4,720
Existing Parshall Flume	$5,160	$0
Existing Outfall	$4,000	$0
Existing Control Building	$5,760	$0
Miscellaneous Upgrades	$131,653	$18,000
Total Salvage Value		**$131,920**

Note: Equipment is assumed to have a salvage value of 0% after 20 years, structures are assumed to have a salvage value of 40% after 20 years, and pipe is assumed to have a salvage value of 50% after 20 years.

Exhibit 6-3.5
Brandenburg Wastewater Treatment Plant
Alternative 3
Diffusers and Polishing Reactor
Present Worth Analysis

Total Project Cost			**$3,312,382**
Present Worth of Annual Operating Cost Calculation			
Annual Operating Cost	$419,374	per year	
Discount Rate	2.875%		
Life of Project	20	years	
Present Worth of Annual Operating Cost			**$6,311,942**
Present Worth of Salvage Value			
Salvage Value	$131,920		
Discount Rate	2.875%		
Life of Project	20	years	
Present Worth of Salvage Value			**$74,837**
Approximate Total Present Worth			**$9,550,000**

Exhibit 6-4.1
Brandenburg Wastewater Treatment Plant
Disinfection Facilities
Alternative 1
Ultraviolet Light Disinfection
Construction Cost Estimate

Description	Quantity	Unit	Unit Cost	Cost
Equipment				
Ultraviolet Disinfection System	1	LS	$41,900	$41,900
Equipment Installation (20%)	1	LS	$8,380	$8,380
Subtotal				**$50,280**
Channel				
UV Channel	1	LS	$28,200	$28,200
Subtotal				**$28,200**
Contractor OH&P (15% of Equipment)	1	LS	$6,285	**$6,285**
Total Construction Cost Estimate				**$84,765**

Exhibit 6-4.2
Brandenburg Wastewater Treatment Plant
Disinfection Facilities
Alternative 1
Ultraviolet Light Disinfection
Operation and Maintenance Cost

Design Conditions			
Average Flow	0.312	mgd	
Peak Flow	0.932	mgd	
Quantity of Lamps			
UV Modules	8	modules	
Lamps per Module	4	lamps	
Quantity of Lamps	32	lamps	
Power Usage at Average Flow			
Average Power Draw	10	kw	
Operating Hours/Day	24	hrs/day	
Operating Days	365	days/year	
Annual Power Usage	87,600	kw-hr/yr	
Cost per kw-hr	$0.07	/ kw-hr-yr	
Total Annual Power Cost			**$6,132**
Replacement Parts			
Annual Percent of Lamp Replacements	25%		
Number of Lamps Replaced	8.0	lamps	
Cost per Lamp	$260	/ lamps	
Annual Replacement Cost			**$2,080**
Miscellaneous			
Annual Lamp Cleaning Cost	$1,000		
Annual Miscellaneous			**$1,000**
Total Annual Operating and Maintenance Cost			**$9,212**

Exhibit 6-4.3
Brandenburg Wastewater Treatment Plant
Disinfection Facilities
Alternative 1
Ultraviolet Light Disinfection
Salvage Value

Description	Cost	Salvage Value
Ultraviolet Disinfection System	$41,900	$0
UV Channel	$28,200	$11,280
Total Salvage Value		**$11,280**

Note: Equipment is assumed to have a salvage value of 0% after 20 years, structures are assumed to have a salvage value of 40% after 20 years, and pipe is assumed to have a salvage value of 50% after 20 years.

Exhibit 6.4.4
Brandenburg Wastewater Treatment Plant
Disinfection Facilities
Alternative 1
Ultraviolet Light Disinfection
Present Worth Analysis

Capital Cost			**$84,765**
Present Worth of Annual Operating Cost Calculation			
Annual Operating Cost	$9,212	per year	
Discount Rate	2.875%		
Life of Project	20	years	
Present Worth of Annual Operating Cost			**$138,649**
Present Worth of Salvage Value			
Salvage Value	$11,280		
Discount Rate	2.875%		
Life of Project	20	years	
Present Worth of Salvage Value			**$6,399**
Approximate Total Present Worth			**$218,000**

Exhibit 6-5.1
Brandenburg Wastewater Treatment Plant
Disinfection Facilities
Alternative 2
Peracetic Acid Disinfection
Construction Cost Estimate

Description	Quantity	Unit	Unit Cost	Cost
Equipment				
Peracetic Acid Pump Skid	1	LS	$30,000	$30,000
Combination Eyewash Shower	1	EA	$10,000	$10,000
Equipment Installation (20%)	1	LS	$8,000	$8,000
Subtotal				**$48,000**
Containment Area				
Reinforced Concrete Walls (Containment)	1	CY	$3,000	$3,000
Reinforced Concrete Slab (Containment)	1	CY	$2,000	$2,000
Subtotal				**$5,000**
Contact Tank				
Peracetic Acid Contact Tank	1	LS	$209,720	$209,720
Subtotal				**$209,720**
Contractor OH&P (15% of Equipment)	1	LS	$6,000	**$6,000**
Total Construction Cost Estimate				**$268,720**

Exhibit 6-5.2 Brandenburg Wastewater Treatment Plant Disinfection Facilities Alternative 2 Peracetic Acid Disinfection Operation and Maintenance Cost			
Design Conditions			
Average Flow	0.312	mgd	
Peak Flow	0.932	mgd	
PAA Usage at Average Flow			
PAA Concentration Feed Rate	1.8	mg/L	
Daily PAA Dosage	31	lb/day	
PAA Cost	$1.00	/ lb	
Days in Operation	365	days	
Annual PAA Cost			**$11,397**
Replacement Parts			
Pump Hose Replacement	12	hoses	
Cost per Hose	$200.00	/ hoses	
Annual Replacement Parts Cost			**$2,400**
Total Annual Operating and Maintenance Cost			**$13,797**

Exhibit 6-5.3
Brandenburg Wastewater Treatment Plant
Disinfection Facilities
Alternative 2
Peracetic Acid Disinfection
Salvage Value

Description	Cost	Salvage Value
Peracetic Acid Pump Skid	$30,000	$0
Combination Eyewash Shower	$10,000	$0
Reinforced Concrete Walls (Containment)	$3,000	$1,200
Reinforced Concrete Slab (Containment)	$2,000	$800
Peracetic Acid Contact Tank	$209,720	$83,888
Total Salvage Value		**$85,888**

Note: Equipment is assumed to have a salvage value of 0% after 20 years, structures are assumed to have a salvage value of 40% after 20 years, and pipe is assumed to have a salvage value of 50% after 20 years.

Exhibit 6-5.4
Brandenburg Wastewater Treatment Plant
Disinfection Facilities
Alternative 2
Peracetic Acid Disinfection
Present Worth Analysis

Capital Cost			**$268,720**
Present Worth of Annual Operating Cost Calculation			
Annual Operating Cost	$13,797	per year	
Discount Rate	2.875%		
Life of Project	20	years	
Present Worth of Annual Operating Cost			**$207,659**
Present Worth of Salvage Value			
Salvage Value	$85,888		
Discount Rate	2.875%		
Life of Project	20	years	
Present Worth of Salvage Value			**$48,723**
Approximate Total Present Worth			**$428,000**

Exhibit 6-6.1
Brandenburg Wastewater Treatment Plant
Disinfection Facilities
Alternative 3
Chlorine Disinfection
Construction Cost Estimate

Description	Quantity	Unit	Unit Cost	Cost
Equipment				
Dual 150 Lbs. Cylinder Digital Scales	2	EA	$3,000	$6,000
Gas Injectors & Cylinder Regulators	4	EA	$3,000	$12,000
Automatic Switchover	2	EA	$1,000	$2,000
Gas Leak Detection System	1	LS	$10,000	$10,000
Equipment Installation (20%)	1	LS	$6,000	$6,000
Subtotal				**$36,000**
Site Work				
Chlorine Contact Tank	1	LS	$209,720	$209,720
Subtotal				**$209,720**
Contractor OH&P (15% of Equipment)	1	LS	$4,500	**$4,500.00**
Total Construction Cost Estimate				**$250,220**

Exhibit 6-6.2 Brandenburg Wastewater Treatment Plant Disinfection Facilities Alternative 3 Chlorine Disinfection Operation and Maintenance Cost			
Design Conditions			
Average Flow	0.312	mgd	
Peak Flow	0.932	mgd	
Influent Fecal Coliform	5,335	/ 100 ml	
Effluent Fecal Coliform	84	/ 100 ml	
Chlorine Usage at Average Flow			
Daily Chlorine Dosage	21	lb/day	
Chlorine Cost	$0.82	/ lb	
Days in Operation	365	days	
Annual Chlorine Cost			**$6,338**
Sulfur Dioxide Usage at Average Flow			
Daily Sulfur Dioxide Usage	7	lb/day	
Sulfur Dioxide Cost	$1.15	/ lb	
Days in Operation	365	days	
Annual Sulfur Dioxide Cost			**$3,004**
Total Annual Operating and Maintenance Cost			**$9,342**

Exhibit 6-6.3
Brandenburg Wastewater Treatment Plant
Disinfection Facilities
Alternative 3
Chlorine Disinfection
Salvage Value

Description	**Cost**	**Salvage Value**
Dual 150 Lbs. Cylinder Digital Scales	$6,000	$0
Gas Injectors & Cylinder Regulators	$12,000	$0
Automatic Switchover	$2,000	$0
Gas Leak Detection System	$10,000	$0
Chlorine Contact Tank	$209,720	$83,888
Total Salvage Value		**$83,888**

Note: Equipment is assumed to have a salvage value of 0% after 20 years, structures are assumed to have a salvage value of 40% after 20 years, and pipe is assumed to have a salvage value of 50% after 20 years.

Exhibit 6-6.4 Brandenburg Wastewater Treatment Plant Disinfection Facilities Alternative 3 Chlorine Disinfection Present Worth Analysis			
Capital Cost			**$250,220**
Present Worth of Annual Operating Cost Calculation			
Annual Operating Cost	$9,342	per year	
Discount Rate	2.875%		
Life of Project	20	years	
Present Worth of Annual Operating Cost			**$140,600**
Present Worth of Salvage Value			
Salvage Value	$83,888		
Discount Rate	2.875%		
Life of Project	20	years	
Present Worth of Salvage Value			**$47,589**
Approximate Total Present Worth			**$344,000**

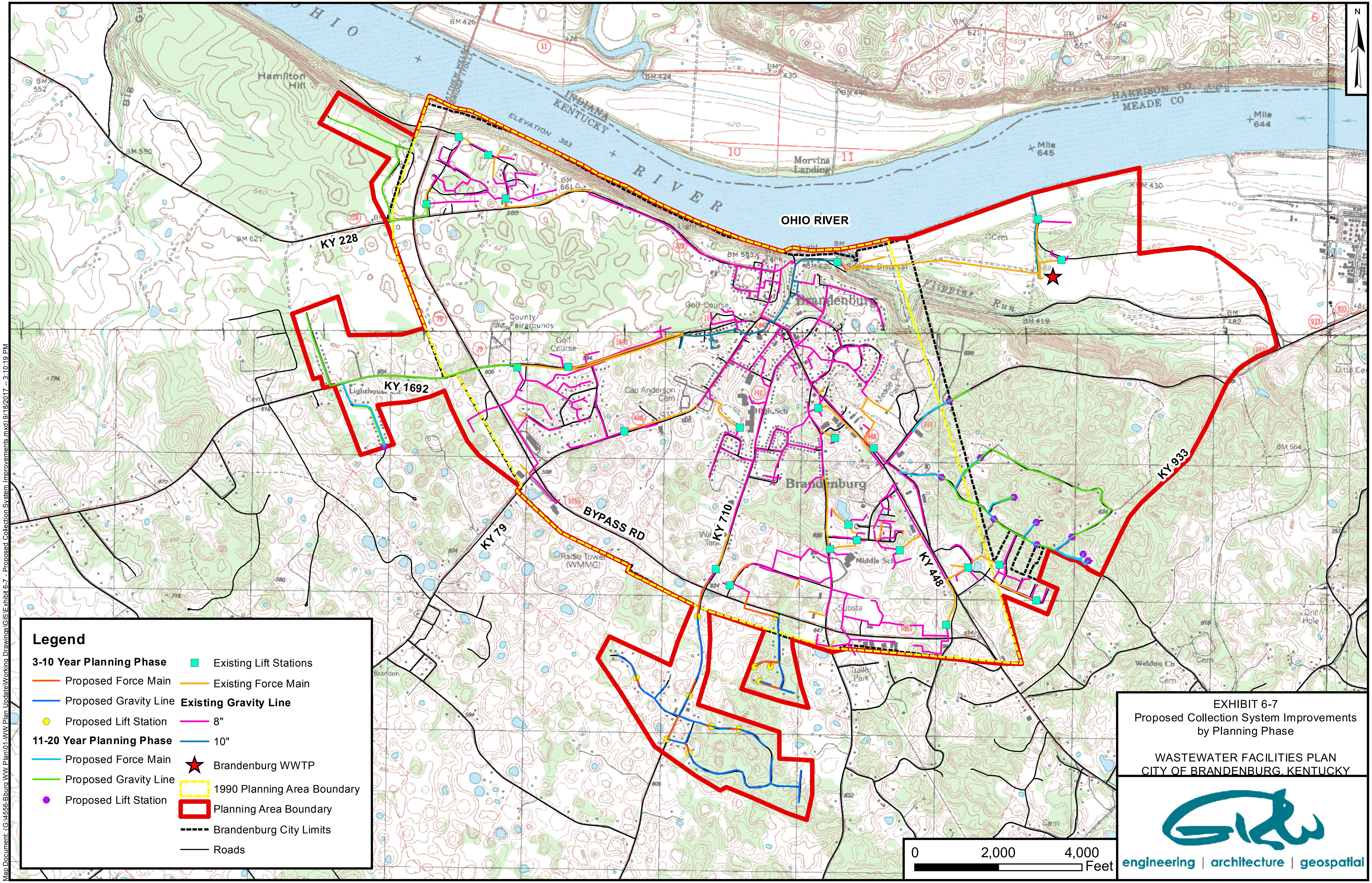

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Exhibit 6-8
Proposed Wastewater Collection System Improvements
Preliminary Total Project Cost Estimate
3-10 Year Planning Phase

Item	Estimated Cost*
Construction	$2,228,000
Engineering Design	$133,000
Site Surveys	$40,000
Geotechnical Engineering	$60,000
Bidding	$19,000
Construction Administration	$38,000
Resident Inspection	$110,000
Land and Right-of-Way	$20,000
Legal	$10,000
Start Up Services	$30,000
Contingency (15%)	$335,000
Preliminary Total Project Cost Estimate	$3,023,000

* Estimated costs based on 2017 pricing

Exhibit 6-9
Proposed Wastewater Collection System Improvements
Preliminary Total Project Cost Estimate
11-20 Year Planning Phase

Item	Estimated Cost*
Construction	$2,791,000
Engineering Design	$161,000
Site Surveys	$60,000
Geotechnical Engineering	$60,000
Bidding	$23,000
Construction Administration	$46,000
Resident Inspection	$127,000
Land and Right-of-Way	$30,000
Legal	$15,000
Start Up Services	$30,000
Contingency (15%)	$419,000
Preliminary Total Project Cost Estimate	$3,762,000

* Estimated costs based on 2017 pricing

Exhibit 6-10
Brandenburg Wastewater Treatment Plant
Present Worth Analysis Summary

Biological Treatment Alternatives*

Alternative	Description	Project Cost	Annual O&M	Salvage Value	Total Present Worth
1	Addition of Polishing Reactor	$4,674,462	$420,374	$161,040	$10,911,000
2	Waving Biomedia	$3,324,690	$431,810	$93,640	$9,771,000
3	Diffusers and Polishing Reactor	$3,312,382	$419,374	$131,920	$9,550,000

Disinfection Alternatives

Alternative	Description	Construction Cost	Annual O&M	Salvage Value	Total Present Worth
1	Ultraviolet Light	$84,765	$9,212	$11,280	$218,000
2	Peracetic Acid	$268,720	$13,797	$85,888	$428,000
3	Chlorination/Dechlorination	$250,220	$9,342	$83,888	$344,000

*The biological treatment alternatives include total project cost for upgrading the City of Brandenburg's WWTP which includes the selected disinfection alternative.

Exhibit 6-11
Brandenburg Wastewater Treatment Plant
Non-monetary Effectiveness Analysis

		Alternative 1 Addition of Polishing Reactor		Alternative 2 Waving Biomedia		Alternative 3 Diffusers and Polishing Reactor	
Parameter	**Weight**	**Rating**	**Score**	**Rating**	**Score**	**Rating**	**Score**
Environmental Impact	1.00	9	9.00	9	9.00	9	9.00
Engineering Evaluation	1.00	8	8.00	8	8.00	10	10.00
Implementability	0.90	10	9.00	9	8.10	9	8.10
Energy Consumption	0.80	8	6.40	7	5.60	9	7.20
Expandability	0.70	8	5.60	9	6.30	9	6.30
Chemical Use	0.70	8	5.60	8	5.60	9	6.30
Public Support	0.80	8	6.40	8	6.40	8	6.40
Institutional & Legal Capability	0.90	10	9.00	10	9.00	10	9.00
Regionalization	0.70	7	4.90	7	4.90	7	4.90
Land Purchase & Easements	0.50	10	5.00	10	5.00	10	5.00
Total Score			**68.90**		**67.90**		**72.20**
Total Present Worth			**$10,911,000**		**$9,771,000**		**$9,550,000**
Non-Monetary Effectiveness Units (NEU)			**158,360**		**143,903**		**132,271**

Note: 1. The **Weight** of each parameter is a measure of the relative concerns of that parameter compared to other parameters, on a scale of 0.0 to 1.0, with the highest weighted parameters being those which are considered the most critical.

2. The **Rating** for each alternative is a measure of the relative implementation concern of that alternative on the parameter compared to other alternatives, on a scale of 0.0 to 10.0, with the highest ratings given to the alternative that best satisfies the parameter.

3. The Non-monetary Effectiveness Unit (NEU) is a measure of the relative implementation concern due to construction and operation of each alternative. The alternative with the **lowest NEU is the most capable of implementation**.

4. Non-monetary Effectiveness Units (NEU) = Total Present Worth/Total Score